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POWER

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Salesman Personality

ONE of my friends received a camera recently as a birthday gift. Full of interest and anticipation, he took it to a store in the neighborhood of his home to be charged with films.

But the individual in charge had seen neophyte Kodakers before. My friend's obvious receptivity elicited nothing more sympathetic or reponsive than the pushing of the desired rolls across the show case and a curt announcement of their price.

The customer had passed larger and better-equipped supply houses on his way home and had brought his new hope to this neighborhood shop in the expectation of neighborly interested service.

He mentioned that he had never used a camera and would appreciate being shown how to load and shoot it, only to be told coldly that he would find the directions inside.

A little sociability and interest, demonstration and advice, would have won that shop a loyal patron. As it is, he will never go back.

A man will go blocks out of his way to buy a handful of cigars because he knows the salesman pleasantly, and will stick to a hotel for years because the clerks call him by name.

More contracts have been closed through the pleasing personality of the seller than upon the merits of the goods, and many a vote has been won by kissing a kid.

Even the written or printed word may be friendly and fetching, and a letter or advertisement that shows a familiar and intelligent interest in the problems of a possible user will excite more favorable impressions and attract more effective notice than one that simply clamors for attention to proclamations of superior merit.

F. R. Low

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Hotter Steam and Colder Helium

WHEN it comes to temperatures one can pretty much take his choice today. In *Power* last week J. W. Parker told of experiments being made with one-thousand-degree steam at a Detroit Edison plant. That means red-hot pipes, literally.

And now comes a newspaper report to the effect that Prof. W. H. Keesom, physicist at Leyden, Holland, has maintained a temperature of 0.82 degree absolute (Fahrenheit degrees) throughout a space of 12.2 cubic inches. This is large enough for important experimental work.

Looking at it one way, —459.6 deg. F. (absolute zero) doesn't seem much colder than 458.6 or 457.6. From another point of view one might argue that 0.82 degree absolute is just twice as cold as 1.64 degrees. This view is more nearly in accord with the difficulty and importance of getting a little closer to absolute zero. Obviously, the absolute zero of temperature, like absolute vacuum, can never be reached, although each generation of scientists may come closer to it.

Superficially, the Detroit Edison experiment may be classified as "practical" and that at Leyden as "impractical," but such distinctions are not justified in the light of scientific history. One may not be able to predict just what practical benefits may come from these low-temperature experiments, but he can be sure that such work will be worth while, as were Faraday's experiments with electricity, Curie's with radium and Langmuir's with atomic hydrogen.

Loeffler Boiler Versus Benson

SOMEWHAT belated, but nevertheless acceptable, is the response in this issue to an editorial note inviting discussion of Professor Loeffler's article on "Steam Generation at High Pressures and Temperatures." This was published in two sections in the March 19 and 26 numbers of *Power*, and the reader may recall that they constituted a comprehensive argument for the superiority of the "steam-pumping" principles for high-pressure steam generation.

Professor Loeffler was allowed to say what he had to say, and in his own way, because his comments were interesting and thought provoking. It was hoped that users and manufacturers interested in other types of high-pressure boilers would come forward with the other side of the argument. Is it true that the "steam-pumping" type of boiler is superior for high-pressure steam generation? If so, that fact is of great importance in this era of rising pressures. If not, will the Benson boiler or some other of the more radical types, leap to the front? Or will the standard cross-drum and inclined-tube multiple-drum types strengthened for high-pressure operation, continue to hold the lead in American high-pressure practice.

The matter is one of broad interest. The "comeback" in this issue is from a representative of the Siemens Schuckertwerke, Berlin, who have carried on the development of the "critical pressure" steam generator invented by Mark Benson. This reply is as obviously an argument for the principles employed in the Benson boiler as was Doctor Loeffler's for his. One need not agree with every statement made (regarding pumping energy, for example) to find it well worth the reading.

It is to be hoped that some engineer thoroughly familiar with the types of boilers now used in American high-pressure practice, will present the picture from still another angle, and thus fill certain notable gaps in the arguments thus far presented.

The Operating Engineer and Opportunities for Saving

RECENTLY, in a visit to a dye works, a thousand-horsepower Corliss engine was found operating condensing, while the dyehouse was consuming enormous quantities of live steam. To a query as to why the engine, which was underloaded, was not run non-condensing and the exhaust used for the dye processes, the engineer explained that as the slightest trace of lubricating oil would ruin the dyes, the exhaust could not be used.

This answer seemed logical, but why was the engineer willing to permit the matter to rest with this discovery? An evaporator or heat exchanger, placed either between the two engine cylinders or in the low-pressure exhaust line would have given either hot water or steam, whichever was desired. This would eliminate all contamination risk and at once save about four tons of coal daily. A saving of six thousand dollars yearly is not to be passed by with upturned nose. It represents a generous dividend on a hundred thousand dollars of capital.

This citation is of but one of many similar conditions that any inquisitive person may encounter in a day's time.

The average factory does not have a consulting or supervisory engineer. It depends upon the operating engineer for suggestions as to methods of reducing power costs, just as it expects the manager of the finishing department to study cost-reduction methods. Unfortunately, the engineer too often is content to maintain the status quo.

Have the Basic Economic Conditions of American Life Changed?

DURING the administration of the late President Harding he called a conference on unemployment, which is still functioning, although the immediate emergency of 1921-22 has passed. This conference is devoting considerable effort to a study of the fundamental causes of unemployment. One of its important activities, that of the Committee on Recent Economic Changes, appointed by President Coolidge, has just resulted in the publication of an exhaustive survey of post-war developments in American economic life.

The object of this survey was to determine the factors acting in America during the period 1922-29 that might cause stable or unstable conditions. Such a marked improvement is evident in the national standard of living and in the state of the people as a whole that questions arose as to the cause of this advance and whether or not it was permanent.

All the factors that might influence, such as the structure and technical conduct of industry, construction, transportation, marketing, labor, agriculture, foreign trade, management, prices and finance, were studied. This work was carried out, in each case, by recognized experts, who drew widely upon all the varied sources of information in the country.

No definite recommendations are made in the survey, but certain important conclusions can be drawn from its perusal. Apparently there are no fundamental differences in conditions that have caused these recent years to show such an improvement over those preceding. Rather, there has been an acceleration in the operation of factors already evident long before 1922, and, also, sections of American life such as the agricultural, which previously had but a slow development, are now rapidly experiencing the changes that came earlier in other fields.

Among the forces that have been active in the economic field for a long time, but now operate at this accelerated pace, are the use of power, improved machinery, scientific management, high productivity per man-hour and suitable financing methods. Higher living standards through these means have long been evident in our life; but the advance made in the years of the survey is immensely greater than any experienced before.

The dependence of production upon adequate consumption is a relationship that has always existed, but has become evident to industry only during these last seven years. Relative price stability during this period has been accompanied by a remarkable increase in production per man-hour of labor and a relative increase in the purchasing power of wages. This has resulted in an increased production of goods being coupled with an increased power of consuming them on the part of the people as a whole.

More significant to the mind of the engineer than any of the factors already referred to, in accounting for the economic difference between these times and those that went before, is the increased use of power. Not only has the growth in power used been three and three-quarter times faster than the increase in population during this period, but power has become available in the most remote parts of the country, so that its use has affected all activities and all people. Only because of this has the unit cost of production been reduced while wages have risen. Only by a constantly increased use of power can these improvements in the economic side of American life be realized in the future.

What is the conclusion that can be reached from reading this survey? It is that, while no new forces, only an acceleration of those already acting, have set the present apart from the past, there is a more enlightened attitude on the part of the people in the country that has made present conditions possible. Though there is no guarantee that these improvements are stable, in the increase and spread of this enlightenment lies our hope for the future.

Steam Turbine Improvements

TO MANY engineers the steam turbine appears to be a well developed machine incapable of much further improvement. Yet it is probably a fact that more money is being spent on turbine research and development today than at any time in its history. One can therefore expect as an inevitable result of this work, that still better and more economical turbines may be had in the future.

Much experimental work is being devoted to nozzle and blade materials. Alloys to withstand higher pressures and temperatures are being investigated. Blading with non-corrosive properties is also being sought. Forms of blades and blade roots are being developed to give the greatest strength under centrifugal stress and also to withstand fatigue stresses from vibration. All the leading turbine builders in America are active in this development work, and some interesting research of one of the British manufacturers has recently been published.

The art of welding has been developed extensively of late. One need not be surprised if it is eventually applied extensively to the construction of both turbine casings and spindles as it has been in a limited way in a few special cases. Why not weld exhaust pipes to turbines instead of using bolts and troublesome gaskets? Also, oil piping, coolers and certain auxiliaries offer a likely field for such work.

All these developments should result in more rugged and durable machines with greater reliability and less outage than at present. What will this mean in improved steam economy? The general principles of design of nozzles, blades, etc., are now fairly well known so that no radical improvement is likely in any one feature. A quarter of a per cent may be gained here, a half a per cent there and so on. In the aggregate it is still possible even on the best and larger turbines to decrease steam consumption a few per cent and with smaller turbines still greater gains are possible. These savings are well worth while for they represent large savings over the useful life of the turbine.

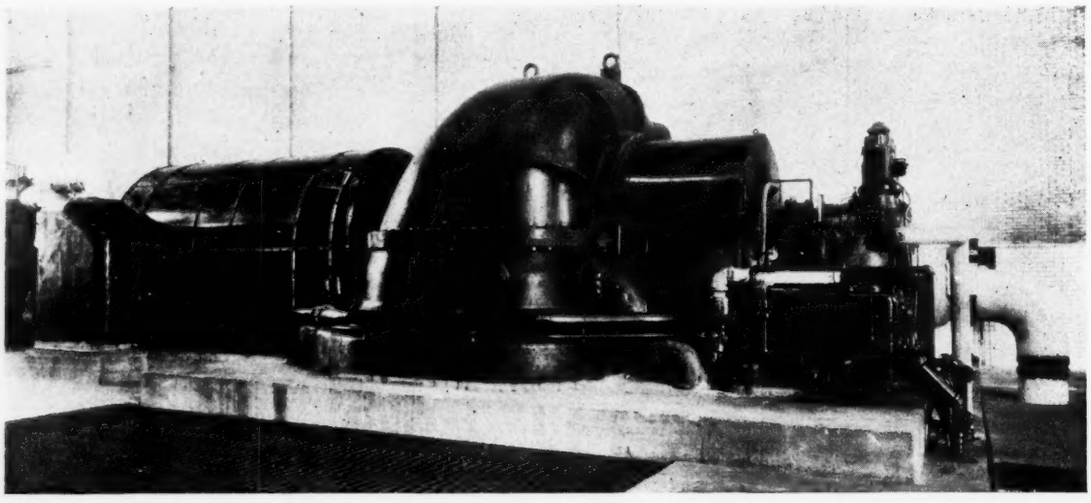
35,000-Kw. Turbine Generator

Moved and Reset in 25 Days

OWING to the growing demand on Cahokia Station of the Union Electric Light & Power Company, of St. Louis, it became necessary to increase the capacity, and to do this without adding to the building the decision was made to transfer unit No. 1, a 35,000-kw. machine, to the Venice Station of the company, giving room in this way for a new turbine-generator of 75,000 kw. capacity.

Work on the removal of the 35,000-kw. turbine-generator and its auxiliaries started on March 2 by a crew of 300 men, working in three shifts of 100 men each. equipment in special trains of a few cars each, whenever they were ready. In all, six special trains were required to move the 27 cars of equipment and the locomotive crane.

On March 9 the turbine casing, the generator bedplates, and the bearing pedestals were mounted in their new location in the Venice power plant, ready to receive the turbine spindle. By March 25 steam was turned into the turbine for testing, and after several tests were made to make sure that everything was as it should be, the unit was placed in operation on March 27, supplying light and



Photograph of the transferred unit taken in the Venice Station on April 13

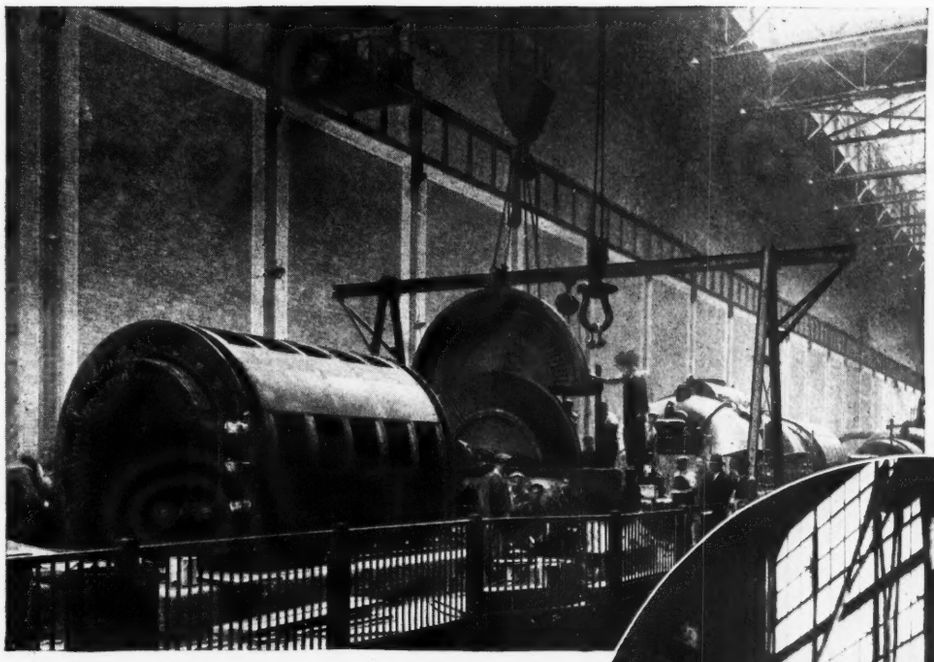
This work continued 24 hours a day until all equipment of the unit had been loaded upon cars by March 9 for shipment to Venice, five miles up the river. The major items removed were the turbine, generator, condenser, generator air coolers, turbine oil cooler, heat exchangers, feed-water heater, boiler-feed pumps, condensate pumps and circulating-water pumps. The size of the pieces varied from the ferrules holding the condenser-tube packing in place and weighing about one ounce each, to the generator stator, weighing 123,000 pounds.

One of the most arduous tasks was the dismantling of the condenser, which necessitated the removal of 10,120 one-inch diameter tubes, 20 ft. long. To remove a condenser tube, a brass ferrule at each end must be unscrewed and the 50-in. strip of corset-lace packing taken from each of the two packing glands. After this the tube was gently pulled out and passed from man to man until it was safely placed in a rack. This operation had to be repeated for each of the 10,120 tubes.

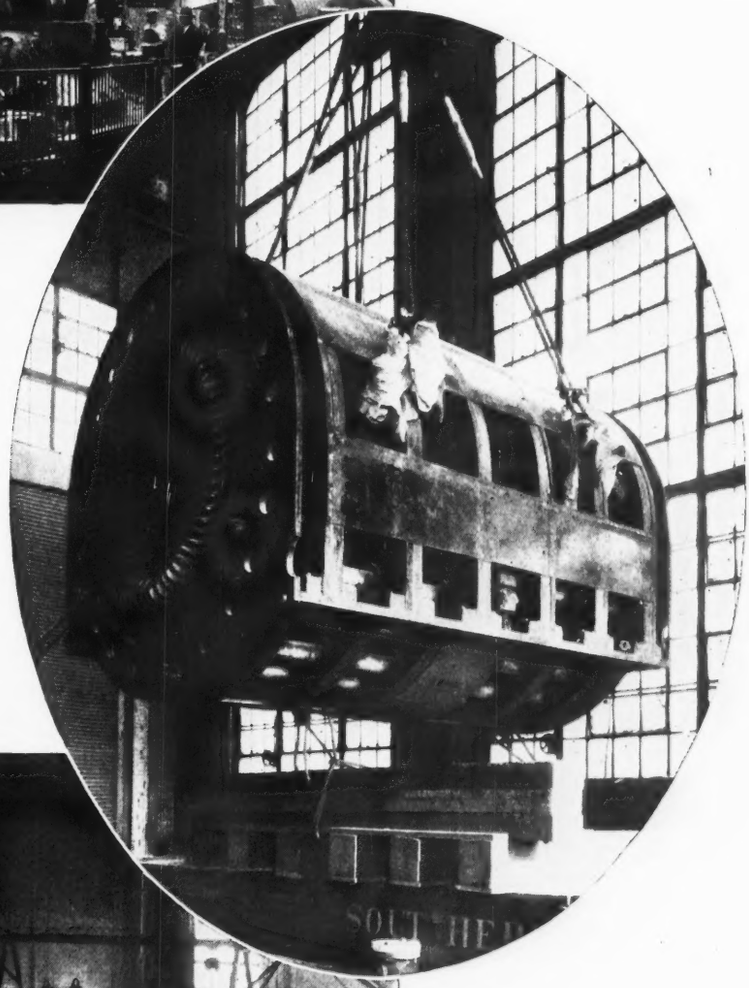
To prevent delay in the progress of the work, arrangements were made with the railroad company to move the power to Greater St. Louis. Those familiar with this work will realize that in completing this task in 25 days the construction department of the St. Louis company made an enviable record.

The new unit to be installed in the space formerly occupied by the 35,000-kw. machine will consist of a 17-stage, single-cylinder, G. E. turbine driving a 13,800-volt 1,800-r.p.m. double-winding generator, rated at 75,000 kw. at 90 per cent power factor. The length of the machine is 57 ft. 8 in., the width 22 ft., the height 15 ft. 3 in. and the total weight 1,110,000 pounds.

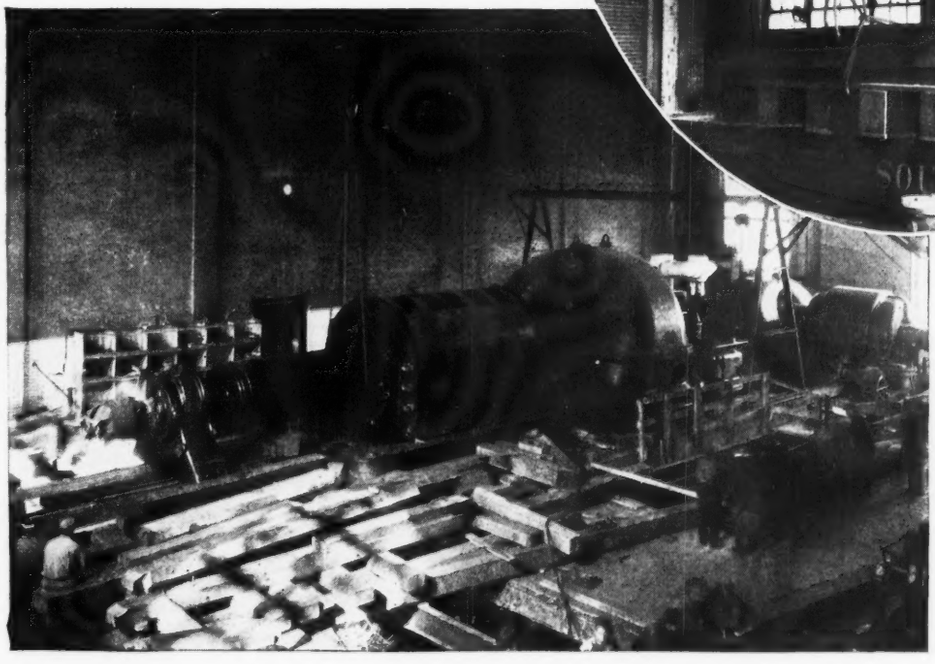
Steam conditions for the unit will be 330 lb. gage and 725 deg. F. total temperature. The new unit will be bled at the eighth and fourteenth stages to heat condensate from the hotwell and from the 35,000-kw. unit No. 2. The eighth-stage steam also will be supplied to a Griscom-Russell evaporator. A final boiler-feed temperature of 315 deg. F. will be obtained in closed heaters, the drips from which will be cascaded, and in a Cochrane deaërating open heater using exhaust steam from house turbines.



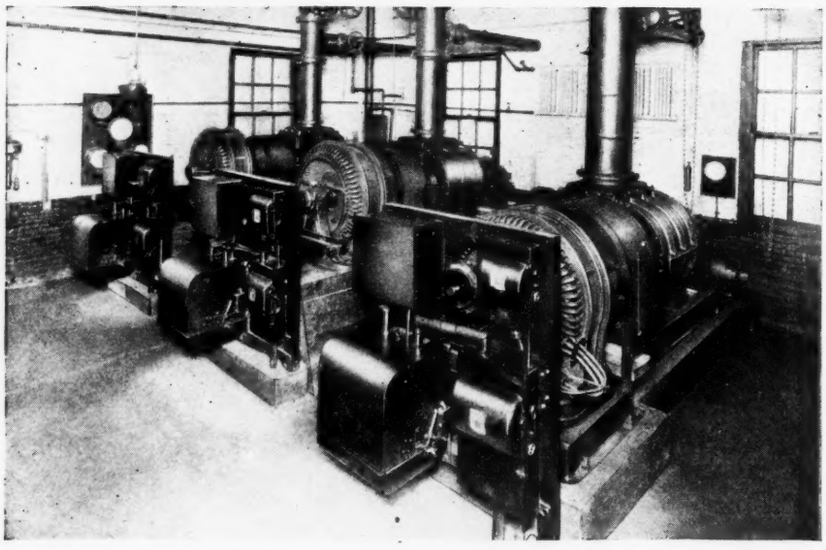
Below — Generator stator suspended from the overhead crane and about to be placed in a cradle built upon the railroad car



Above—View in Cahokia turbine room, showing the removal of the diaphragms from the turbine wheel case after the dismantling had been under way for 27 hours. It also shows the generator with the rotor, exciter, end bearing and housing removed



Left—Generator rotor going into place at Venice Station on March 20



Synchronous motors driving gas blowers have manual starts and automatic field control

Synchronous Motor Starting

Reduced to Pushing a Button

By S. P. Bordeau

Engineer
Electric Machinery Manufacturing Company

How shall the motor be started? Shall manual or automatic control be used? These are questions that frequently face the user and are answerd in this article

SELECTION of synchronous motor drives involves consideration of both the motor and the control. For best results the two should be considered collectively. The increased popularity of synchronous motors for all types of drives is due, to a large degree, to the development of automatic starters which reduce starting to the simple operation of pushing a button. Automatic and semi-automatic types of starters make synchronous-motor starting as simple as for squirrel-cage induction motors. Where automatic starters are used, the starting of synchronous motors may be entrusted to unskilled help with assurance that the operation will be properly performed and the motor protected.

Successful application of synchronous motors to high-torque drives, hammermills, hogs, shredders, etc., is possible because of control equipment that permits automatic resynchronization of the motor in case it pulls out of step from peak loads.

A synchronous motor is a combination synchronous and induction type. To operate as a synchronous motor the rotor that carries the field winding must revolve at synchronous speed; that is, the magnetic poles produced by the direct-current-excited field winding must lock into step with the revolving field set up by the armature winding. To pull into step the rotor's speed must be within approximately 95 per cent of the armature's field speed. If there is more than 5 per cent difference in speed when field excitation is applied, a bucking action is set up and the rotor quickly comes to rest.

In the modern synchronous motor the motor and connected load are brought up to synchronous speed by the induction-motor torque produced by a squirrel-cage winding in the pole faces. From standstill to approximately 95 per cent full speed the motor operates as an induction motor. At 95 per cent speed, or very nearly, depending on the design of the motor, direct-current excitation is applied to the field winding. The magnetic poles of the rotor then synchronize with those of the armature and the motor runs at synchronous speed, as a synchronous motor.

Starters for synchronous motors must: (1) Connect the motor to the line, either at full or reduced voltage; (2) apply field excitation at the proper speed for synchronizing. In addition they should completely protect the motor from abnormal line or load conditions, should remove field excitation when the motor is shut down, and have the proper indicating instruments to permit the best operation. It is also desirable that the

starters should automatically remove excitation when the motor is out of synchronism, so that resynchronizing will take place automatically if motor torque characteristics permit. Obviously, the foregoing are obtained completely only in the automatic starter.

In general the selection of a starter for a synchronous motor requires consideration of:

1. Manual or automatic starting.
2. Full- or reduced-voltage starting.
3. Oil- or air-break line contactors.
4. Indicating instruments.
5. Motor protection.

Development of synchronous-motor starting has been from the manual to the automatic type. Today, manual starting has largely been supplanted by automatic starting. This trend is true of starters for all types of motors, but particularly so for synchronous motors.

Automatic control has the advantage of greater dependability through assurance of correctness in the starting operation and because it better protects the motor from abnormal conditions. Push-button control permits starting by untrained help and allows the advantages of remote control, float-switch control, pressure control, etc. With automatic control the operator cannot impose undesirable conditions upon either the starter or the motor. It also enables the operator to pay entire attention to the machine being started without being concerned with the starting of the motor.

The use of semi-automatic starters has become popular for the smaller sizes of synchronous motors, where the greater expense or the advantage of push-button starting does not warrant the full-automatic starter. With semi-automatic starters connection to the line is made by an oil switch for full-voltage starting and a compensator for reduced-voltage starting. Application of the field during starting and removal of the field when the motor is shut down is done automatically.

Whether full- or reduced-voltage starting shall be used will depend on:

1. Torque that the motor must develop to start and accelerate the connected load to synchronous speed.

2. Starting current with full voltage applied to the motor terminals, and its effect on the power circuit to which the motor is connected.

3. Conditions imposed by the driven load.

It is practice now to use full voltage almost exclusively with medium- and slow-speed motors. Full-voltage starting allows using a less expensive starter with fewer parts and hence less maintenance and makes the full starting torque of the motor available. Full-voltage starting is, in general, finding favor with the power companies because it shortens the time of starting and eliminates the second bump on the line caused by reduced-voltage starters when transferring from reduced to full voltage.

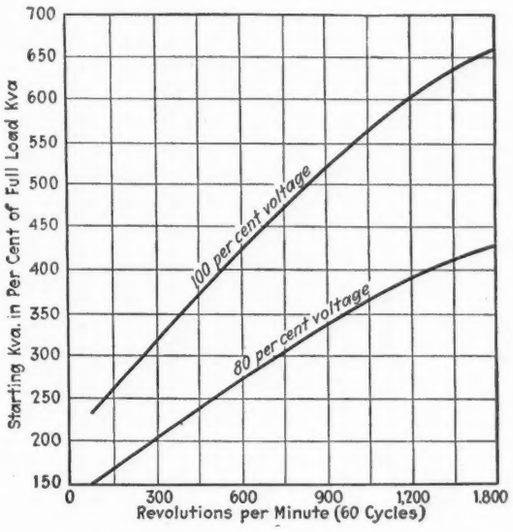
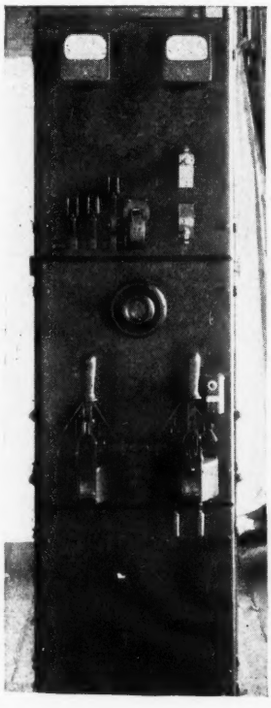


Fig. 4—Approximate per cent kva. inrush for synchronous motors at 100 and 80 per cent starting voltage

Fig. 4 shows the approximate current inrush at starting for unity-power-factor synchronous motors at va-



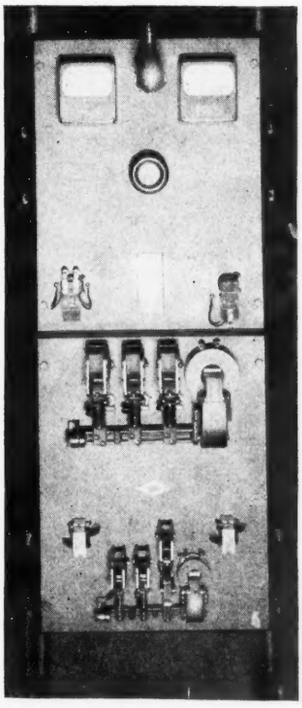
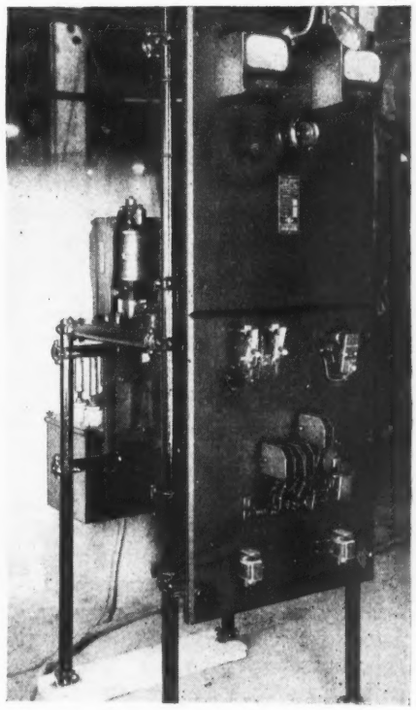


Fig. 1 (Left)—Manual reduced-voltage starting panel with automatic field switch

Fig. 2 (Left-center)—Full-voltage air break type automatic starter for use with a 175-hp. 138-r.p.m. 550-volt unity-power-factor synchronous motor

Fig. 3 (Right)—Full-voltage oil-break type automatic starting panel for 210-hp. 257-r.p.m. 4,600-volt 0.80-power-factor synchronous motors



rious speeds and at 100 and 80 per cent full voltage. As will be noted, starting current increases with increased motor speed.

At speeds above 600 r.p.m. reduced-voltage starting is usually required. The starting torques that can be obtained with high-speed motors are usually sufficient, on reduced voltage, to bring the load up to the speed required for synchronizing. The normal current inrush of 500 to 600 per cent can be reduced, by using 80 per cent starting voltage, to from 300 to 400 per cent, or by using a lower voltage tap can be reduced to a lower value. Where high-speed motors are belted to the load it will usually be necessary to use reduced voltage to avoid excessive belt slippage or possible throwing off the belt. The inherent high-starting torques of high-speed motors may make it necessary to use reduced voltage to decrease shock to the speed-reducing devices and connected load.

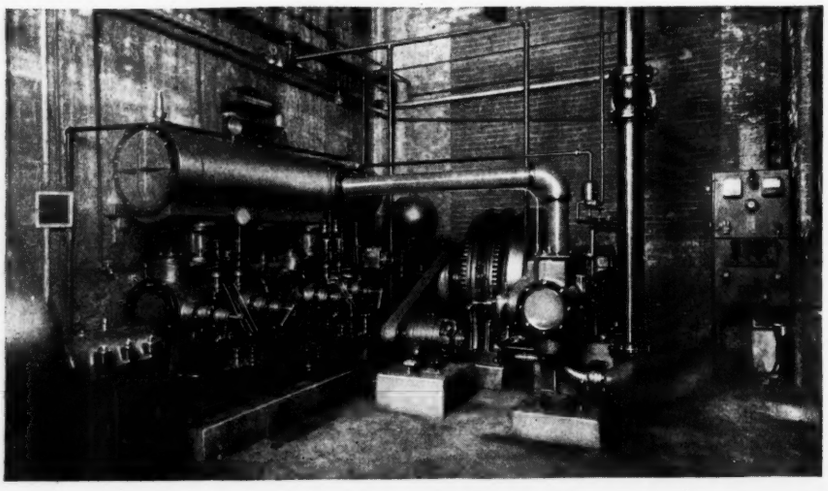


Fig. 5 (Above)—A 150-hp. 277-r.p.m. 440-volt 60-cycle synchronous motor with automatic full-voltage starter driving a three cylinder air compressor

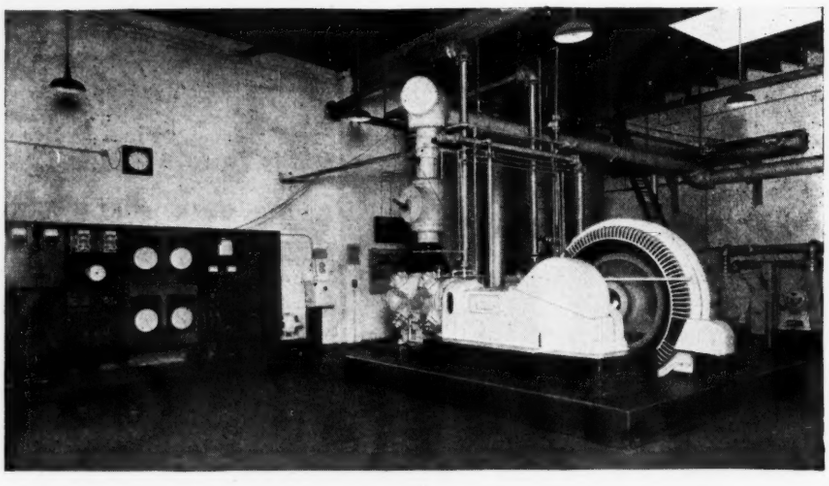


Fig. 6 (Right)—A 250-hp. 2,200-volt 257-r.p.m. 60-cycle unit-power-factor motor with automatic full-voltage starter driving ammonia compressors

The effect of synchronous-motor starting on voltage regulation and on lighting loads will also determine whether full-voltage starting can be used. Power companies in many localities stipulate whether a full-voltage starter can be employed. Where lines and transformers and the power system have sufficient capacity, full-voltage starting recommends itself at all but the high speeds.

Air-break line contactors, because of their greater simplicity and lower cost are generally used on automatic starters for voltages up to and including 550. In the larger horsepower ratings, however, to secure sufficient current make-and-break capacity oil-break line contactors may be used. Line contactors for voltages above 550 are oil-break.

Reliability of a motor requires that it be protected from abnormal line and load conditions and that it be provided with devices which minimize interruptions due to momentary power dips. The starter should provide:

1. Overload protection.
2. Protection from phase failure.
3. Protection against operation without field excitation.
4. Undervoltage protection.
5. Provision for removal of field excitation in case the motor is pulled out of step or stops.
6. Provision for automatic resynchronization.

These protective features are obtained completely only in the automatic starter.

Overload protection is required to prevent damage to the armature of the motor by overheating. Excessive currents in the armature may be caused by overload, by low voltage, or by failure of excitation.

Overload relays of the thermal type are used almost exclusively on present-day automatic starters. These relays have an inverse-time characteristic which follows closely the heating characteristic of the motor and thus allows ample time for starting and prevents undue shutdowns where overloads are not continuous or harmful.

On large motors at high voltage, and on groups of motors where a large amount of power is concentrated, the destructive possibilities of a short circuit between the motor and control panel are eliminated by providing a breaker separated from the contactors on the board. An instantaneous overload relay, short-circuited during the starting period, transfers the opening of the short circuit to the remote circuit breaker.

Protection from phase failure is usually obtained by means of the overload relays. The increase in current on single-phase operation will be sufficient to trip the thermal overload relay after a short time.

Failure of direct-current excitation, causes operation as an induction motor or, where the motor has insufficient induction-motor torque to drive the load, results in stopping. The increase in current will trip the overload relays. Relays that will open the line switch imme-

diately on failure of excitation are sometimes provided.

Undervoltage protection is usually provided for in the line contactors. Failure of voltage will open the control relays or trip the holding coil on the line contactors, preventing the reapplication of voltage when power is restored. To avoid undue sensitivity to momentary voltage dips the undervoltage trips are usually made

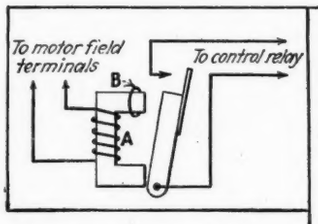


Fig. 7 (Above)—Diagram of frequency relay

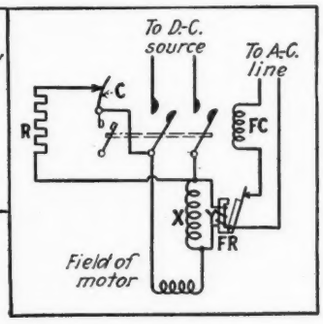


Fig. 8 (Right)—Diagram of field-contactor circuit

to be inactive except for voltages less than 40 per cent normal.

Frequency-relay controlled automatic starter for synchronous motors utilizes the declining frequency in the field winding during starting to operate the control. As is well known, the field winding of the motor has induced in it, by transformer action, a voltage that will cause a current to flow if the field circuit is closed. The frequency of the induced current declines as the motor accelerates from standstill to synchronism, as shown by the oscillogram of Fig. 9. If the line frequency is 60 cycles, the frequency of the field current will be 60 cycles at standstill, 30 cycles at half-speed, and zero at synchronous speed. Obviously, the frequency of the field current is an exact measure of motor speed. Its use in the frequency-relay controlled starter permits correct operation of the control steps without regard to load conditions or the time required for the motor to accelerate.

For reduced-voltage automatic starters, two frequency relays are used; one transfers the motor from reduced to full voltage at the desired motor speed, and the other controls the field contactor and applies field excitation at the correct speed for synchronizing. Full-voltage starters use only the second frequency relay to apply field excitation.

The diagram, Fig. 7, illustrates the operation of the transfer relay. As has been pointed out on the oscillogram in Fig. 9, at point *A* an alternating current of 60-cycle frequency (in the case of a 60-cycle motor) flows through coil *A* when the motor is first started on reduced voltage. This current would immediately close the relay except for the copper damping ring *B*. The alternating magnetic field set up by the current in coil *A* induces a current in damping ring *B*, which produces a magnetomotive force opposed to that set up by the current in coil *A*. As long as the frequency of the current flowing coil *A* is high, the opposition of damping ring *B* is sufficient to prevent the relay closing against a spring tension. When the frequency declines to a sufficiently low value, the opposing effect of the damping ring *B* falls and permits the relay to close. Closing of this relay is adjustable between 40 and 90 per cent of motor speed, by a simple adjustment of the air gap and spring.

The second frequency relay is likewise adjustable, but over a much smaller range. Its operation can be best understood by referring to Fig. 8. During the starting period a current of declining frequency is flowing through the closed field circuit made up by the field winding, reactor *X*, field-discharge resistance *R* and field-discharge clip *C*. Shunted across the reactor *X* is the frequency relay *FR*. As the reactor has a low resistance and high reactance at high frequency and the relay coil has a comparatively high resistance and low reactance at high frequency, at starting a current is caused to flow through the coil that closes the relay when the motor is connected to the line. The relay opens and thus closes the field contactor *FC* when the frequency of the rotor current declines to a predetermined value, usually three cycles (see point *D* of Fig. 9) corresponding to 95 per cent motor speed. This relay is accurate and, when once set, will always apply excitation at the correct motor speed.

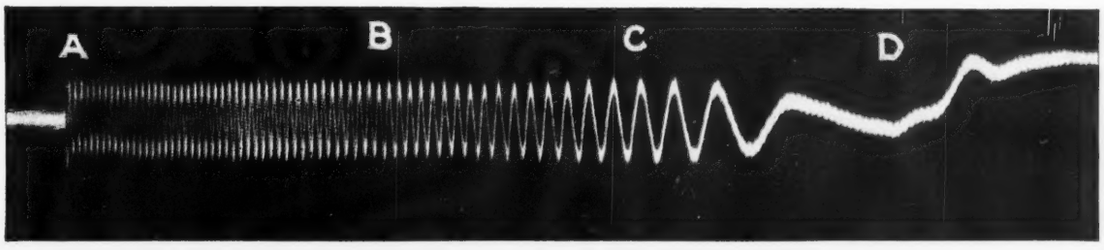


Fig. 9—Oscillogram of the rotor-circuit frequency of a 60-cycle synchronous motor during the starting period

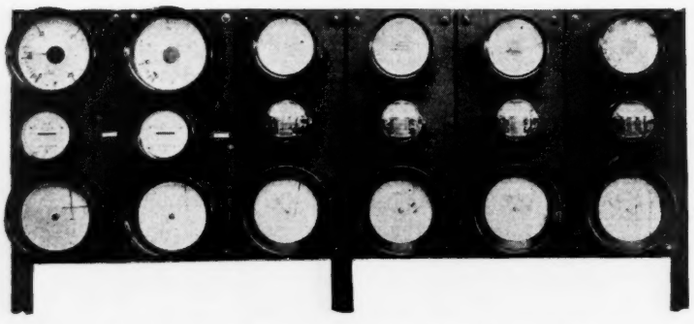
At *A*, the field-circuit frequency is 60 cycles and the motor's speed is zero; at *B* the frequency is 36 cycles and the speed is 40 per cent; at *C* the frequency is 6 cycles and the speed 90 per cent; at *D* the frequency is 3 cycles and the speed 95 per cent of synchronous. Direct-current excitation was applied at *D* and the motor pulled into synchronism.

Another important feature of the frequency-relay system of control is that the excitation is automatically removed if the motor should, for any reason, get out of step. The usual cause is a momentary loss and immediate restoration of power, commonly called a voltage dip. Assuming a three-second voltage dip, a synchronous motor driving a centrifugal pump will drop to approximately 80 per cent of full speed. When normal voltage is restored, the frequency relay that closed the field contactor will now open it, thus permitting the motor to accelerate to full speed and synchronize.

Without the frequency-relay system of control the motor, when running below synchronous speed with excitation applied, will come to a stop, regardless of the amount of load, taking heavy inrushes of current from the line, which will, eventually, trip the overload relays.

P. & F. CORBIN PLANT

Reports Operating Data for 1928



Departmental meters for steam and electricity

COST and production figures for several years' operation are now available for the power plant of the P. & F. Corbin Division of the American Hardware Corporation, New Britain, Connecticut. This plant, which went into operation in 1924, also supplies power and steam for heating and process to the adjacent Corbin Cabinet Lock Division.

The equipment includes four stoker-fired 5,060-sq.ft. water-tube boilers with integral economizers, two 2,000-kw. (at 80 per cent power factor) bleeder turbines and one 500-kw. bleeder turbine, with surface condensers and cooling tower, two motor-driven air compressors, steam- and motor-driven auxiliaries, deaërating feed-water heater, automatic combustion control, boiler meters and meters for feed water and steam to turbines, process and heating.

The following operating data for 1928 were furnished by C. H. Norris, mechanical engineer, American Hardware Corporation. The photographs shown were taken recently by a member of the *Power* editorial staff.

DISTRIBUTION OF STEAM

(Standby and special services prorated)
(Thousands of Pounds)

Power	82,881
Process	84,092
Heating	87,730
Total	254,703

DISTRIBUTION OF POWER

	(Total Kilowatt-Hours)
Generated power to mill	5,292,990
Generated power used in power house, mostly for air compressing and special power services	1,329,010
Total power generated	6,622,000
Purchased power	10,900
Total power used	6,632,900

The following tabulations of boiler-room and turbine-

TABLE OF EQUIPMENT

Boilers

Number and type	4, Bigelow Hornsby, water tube
Heating surface (steaming), sq.ft	5,060
Economizers, type	Integral
Superheaters, make and type	Convection, Foster
Maximum continuous rating	300 per cent
Steam conditions	240 lb. gage, 100 to 125 deg. sup.

Stokers

Type and size	Underfeed, 21-tuyere, single-dump
Make	Westinghouse
Drive	In pairs from turbine, through speed reduction (with duplicate Westinghouse motor drive)
Ash dumps	Power operated

Coal and Ash Handling

Boom crane (coal storage)	Derrick & Hoist Constr. Co.
Car hopper	Easton Car & Constr. Co.
Skip hoist	Stephens-Adamson Co.
Coal elevator (bucket)	Stephens-Adamson Co.
Coal bunker (tank type)	Stephens-Adamson Co.
Weigh larry	Stephens-Adamson Co.

Feed-Water Equipment

Boiler feed pumps	3, A. S. Cameron Pump Wks. 2 Westinghouse turbine driven
Drive	1 Westinghouse motor driven
Deaërating heater	Cochrane Corp.
Filters	4 Blackburn-Smith Co.
Makeup water	About 20 per cent, very good
Feed treatment	(None)

Boiler-room Control and Instruments

Combustion control units	4, Hagan Corporation
Feed-water regulators	4, Copes
Air-steam-flow meters	4, Bailey Meter Co.
Recording thermometers, feed water	Brown Instrument Co.
Recording thermometers, steam	Taylor Instrument Co.
Recording pressure gages, steam	Ashcroft

Other Boiler-room Equipment

Forced-draft fans	2, American Blower Co.
Drive	1, Westinghouse turbine; 1, Westinghouse slip-ring motor
Soot blowers	Diamond Power Specialty Co.
Non-return valves	Edwards Valve Co.
Safety valves	Consolidated
Blowoff valves	Everlasting valve with Edwards master valve
Motor-operated gate valves on steam main	Chapman Valve Co.
Holly return system for power-house drips.	

Main Turbine Generators

Bleeder units, 2,000-kw., 600-volt, 3-phase, 60-cycle	2, Westinghouse
Bleeder units, 500-kw., 600-volt, 3-phase, 60-cycle	1, Westinghouse
Throttle conditions	250 lb., 125 deg. sup.
Bleeder pressure	20 lb.

Condensers

For 2,000-kw. units, 2,000-sq.ft., surface	2, Westinghouse
For 500-kw. units, 1,000-sq.ft., surface	1, Westinghouse
Vacuum (average)	27.5 in.
Circulating pumps	Westinghouse Elec. & Mfg. Co.
Cooling tower	Edwin Burhorn Co.

Other Turbine-room Equipment

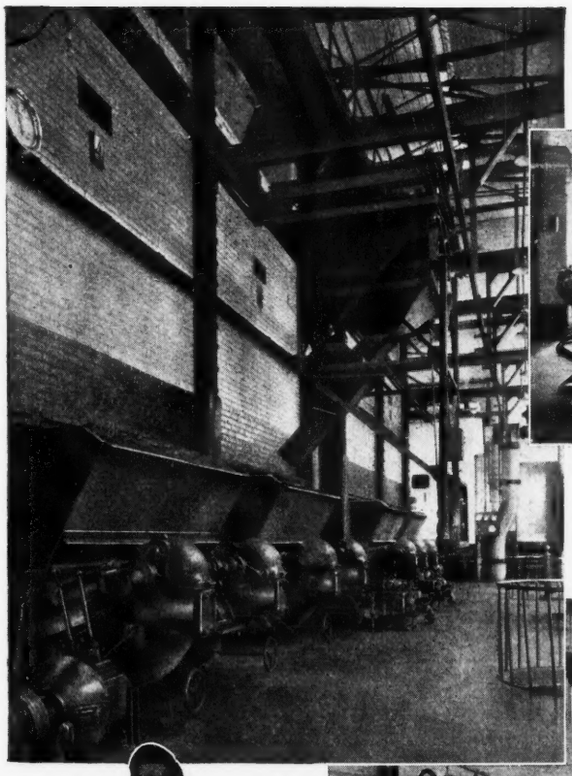
Motor-generator set kw. (output) for D.C.	Westinghouse
Exciter, motor and turbine drive	Westinghouse
Steam-flow meters	Republic Flow Meters Co. and Builders Iron Foundry (shunt)
Switchboard, remote control	Westinghouse Elec. & Mfg. Co.
Vacuum gages	Taylor Instrument Co.

Air Compressors

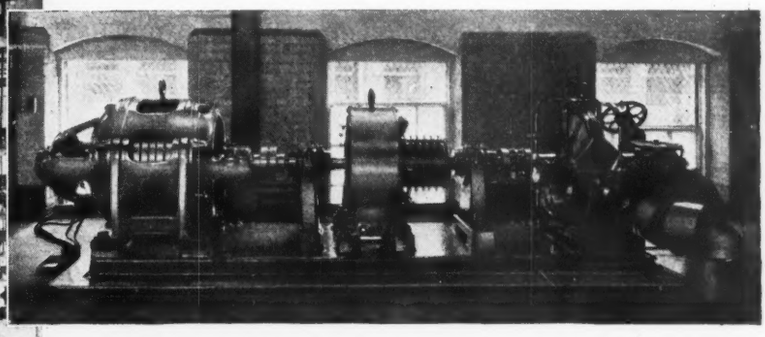
Two-stage	2, Ingersoll-Rand Co.
Compressor drives, synchronous motors	Westinghouse

Miscellaneous Equipment

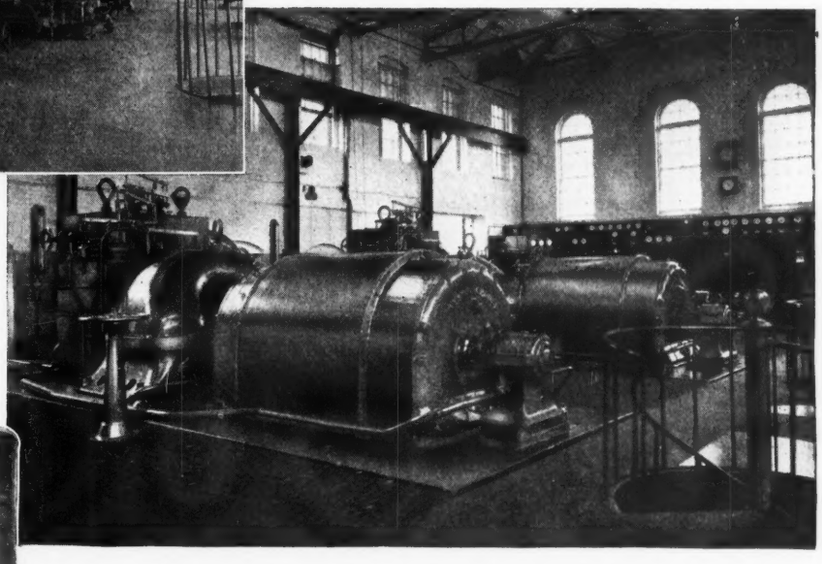
Vacuum cleaning system	Spencer Turbine Co.
Heating steam control	Minneapolis-Honeywell Regulator Co.
Heating system	Donnelly differential system on return
Heating system	Donnelly orifice control on feed



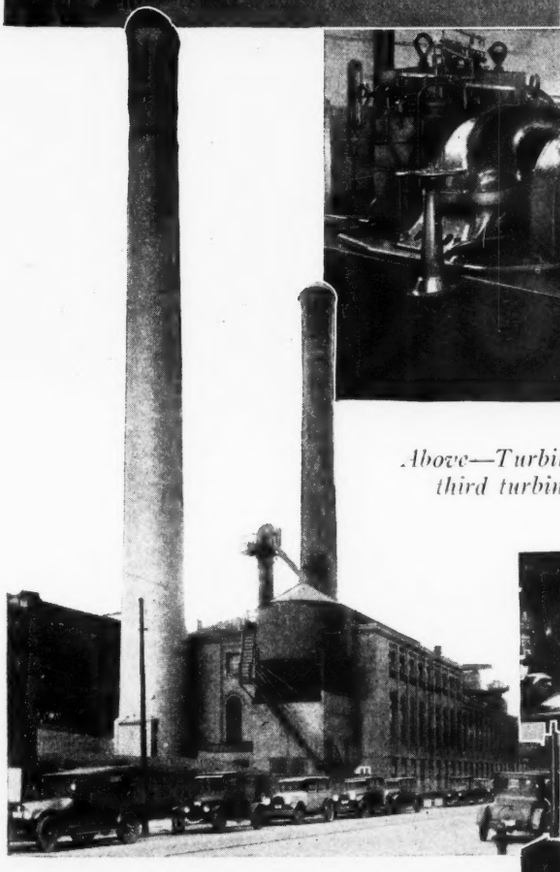
Left—Beyond the four 5,060-sq.ft. water-tube boilers with underfeed stokers may be seen the deaërating heater



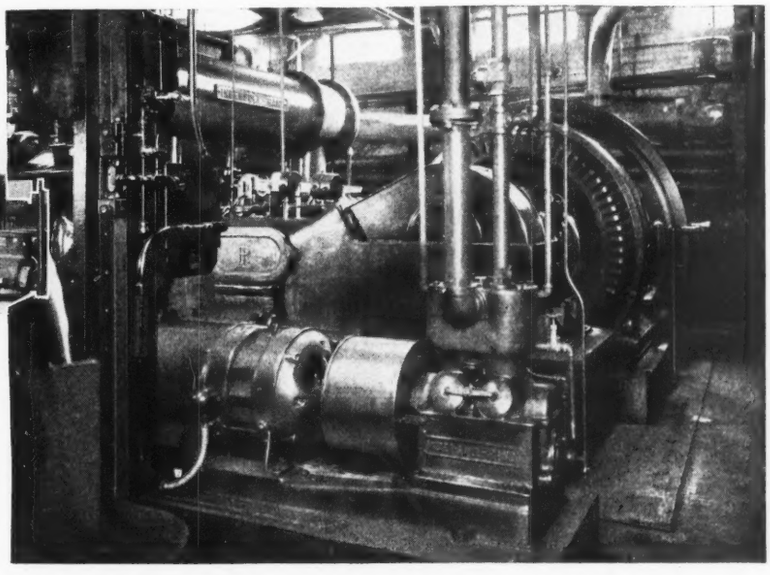
Above—Auxiliary excitation is furnished by a generator with motor and turbine drive



Above—Turbine room, showing two 2,000-kw. bleeder units. A third turbine generator (500 kw.) is located at the far end



Above—At left of large stack is cooling tower and at right outside coal bunker



Right—One of two air compressors driven by synchronous motors

room expense include general overhead as well as fixed charges based on a twenty-year life. In connection with the total cost of steam it should be noted that coal, which constitutes more than half of the total, is naturally expensive in New England. In spite of this high unit fuel cost, generation of a large part of the power as a by-product of bled steam made possible a net power cost for the year of 1.25 cents per kilowatt-hour.

BOILER-ROOM EXPENSE
(Fixed charges on basis of 20-year life)

	Total	Cents per 1,000 Lb. of Steam
Wages	$13,649	5.36
Water	4,703	1.84
Supplies	372	0.15
Repairs	7,125	2.80
Coal	84,316	33.10
Overhead	4,504	1.77
Fixed charges	16,846	6.61
Total	$131,515	51.63

TURBINE-ROOM EXPENSE

	Total
Wages	$15,346
Water	83
Supplies	1,008
Repairs	2,926
Overhead	5,064
Fixed charges	14,599
Total	$39,026

COMBINED COST OF ALL POWER SERVICES

Boiler room	$131,515
Turbine room	39,026
Purchasing power	250
Total	$170,791

CHARGES AGAINST POWER GENERATION

Steam (82,881 x 0.5163)	$42,791
Turbine-room expense	39,026
Purchased power	250
Total	$82,067

Per kilowatt hour ($82,067 ÷ 6,632,900) = $0.0125 or 1.25 c.

COMPUTATION OF BOILER EFFICIENCY

Average feed temperature	210 deg.
Average heating value per lb. dry fuel	15,163 B.t.u.
Average heating value per lb. fuel as fired (3 per cent moisture)	14,708 B.t.u
Steam pressure, gage	231 lb
Superheat	113 deg
Actual evaporation per lb. coal fired	10.20 lb
Heat in steam	1,266 B.t.u
Heat in feed water	178 B.t.u
Net heat supplied per lb. steam	1,088 B.t.u.

Efficiency (1,088 x 10.20) ÷ 14,708 = 75.4 per cent

Metering Equipment Must Be Handled With Care

By H. S. Edgerly

Switchgear Engineering Department
General Electric Company

TO MAINTAIN the accuracy that is expected in instruments, they must be of a delicate construction and should therefore be handled as carefully as the most cherished timepiece. On account of careless handling trouble has been experienced, inaccuracy has developed in the instrument, which could have been avoided by proper handling.

In most instruments the weight of the moving element on the jewels is in the neighborhood of 20 tons per sq.in. It can, therefore, be readily seen that a sharp rap on the table upon which the instrument rests is likely to crack a jewel or dull a pivot, thereby causing a sluggish movement of the needle.

Fig. 1 shows a sketch of a pivot in good condition, while Fig. 2 shows one that has been damaged by improper handling of an instrument. These figures are made from microscopic photographs of pivots before and after tests that were made to determine how badly the pivots were mushroomed after specific test. One fact that should always be remembered is that any electrical measuring device should be treated as a human being, who, when ill, requires the services of an experienced physician. An inexperienced person should not be permitted even to remove the cover from an instrument.

Watt-hour meters are made in various sizes weighing from 9 to 500 lb. The pivots are made of strong steel piano wire and in some instances carry on their jewels a weight equivalent to 75 tons per square inch.

Transformers must also have high accuracy, as otherwise all effort to furnish accuracy for meters would be wasted. Current transformers are built in capacities of from a fraction of an ampere to 20,000 amperes, and potential transformers from 110 to 220,000 volts. They vary in weight from 6 lb. to 15 tons each. Regardless of the size the transformers must conform to definite accuracy requirements. Strict requirements are imposed

Fig. 1—Enlargement of a meter pivot in good condition

Fig. 2—Enlargement of a meter pivot mushroomed by shock

on the mechanical limits of dry-type current transformers.

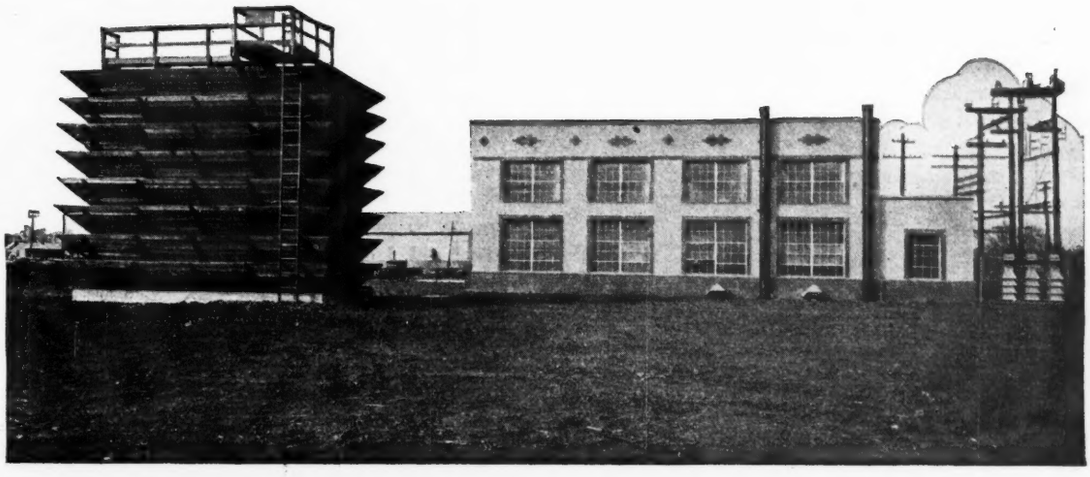
Accidents in various forms will occur on any power system, and the transformers are what might be termed the nerve center of power equipment. They are responsible for the starting of operations of the various devices installed, to protect automatically the lines and machines from disaster that would otherwise result from excess current or other causes. Transformers should, therefore, be handled with care to protect the insulation. They should not be considered as a reactance, or a mass of copper and iron united by compound, but rather as a piece of apparatus that may easily be damaged.

World's Largest Theatrical Switchboard

WHEN the National Electric Light Association convenes in Atlantic City this week, another milestone in the history of the development of lighting will have been passed. For at that time the illuminating system of the Atlantic City Auditorium, far exceeding in size any previous installation, will be demonstrated to the public.

The record-breaking theater switchboard equipment for controlling the lighting system, which was produced by the Westinghouse Electric & Manufacturing Company, places at the finger tips of an operator control of enough power to light a city of 10,000.

A total of 1,800,000 watts of electric power—more than 2,400 hp.—is distributed through the switchboard to illuminate the auditorium chamber, the auditorium stage, the ballroom and exterior flood-lighting. The individual boards controlling each of these sections are of the multi-preset type commonly used in the large theaters of the United States for producing innumerable scenic effects for supporting the play being presented.



WATER PUMPS
for Diesel Engines

By L. H. Morrison
Associate Editor, Power

THE Diesel plant requires so few auxiliaries that the engineering of this equipment is often slighted. Consequently, in many cases the pumps of the cooling-water system are entirely unsuited for the particular layout. Many engine stoppages can be traced to the faulty application of pumps that were designed for entirely different services.

The factors that should control the choice of the water pumps are reliability, suitability for the particular installation, low cost, efficiency and accessibility.

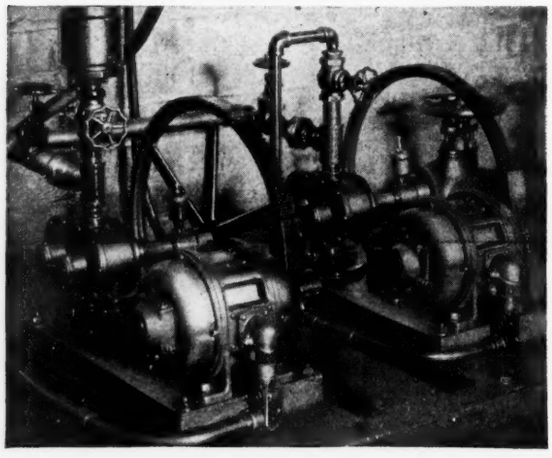
Operation of the engine must necessarily cease upon a failure of the water supply, which directly depends upon the continual functioning of the pump. The design must be such that failure of any part is remote. This is especially vital in installations where the cooling tower is at the ground level and a pump forces the water through the jackets while a second pump lifts it from a discharge sump and forces it over the tower. In some plants the water flows from the cooling tower to the engine, and the pump merely lifts the water from the hotwell, or sump, and delivers it over the cooling towers. If the capacity of the power-sump storage is ample to supply water for an hour or two, a pump less reliable than otherwise demanded, might be used.

Variable capacity is a most desirable feature in the cooling-water pump. The amount of water needed by the engine is in fairly constant ratio to the load. The cooling system must be designed for full-load cooling and should, in fact, be capable of meeting a 25 per cent engine overload. On light loads the water flow can well be reduced; in such installations as have the pump forcing the water through the jacket, a constant flow is seldom satisfactory. If the water discharge temperature of, say, 140 deg. is the best for the engine, on light loads there will not be so much heat for the water to absorb, and the discharge temperatures will drop down to within a few degrees of the inlet or cooling-tower temperature. Not only will the engine's fuel consumption increase, but the pump power becomes a larger percentage of the engine's output. It is possible to maintain the jacket temperature by a valve-controlled bypass between the pump suction and discharge; this, however, does not reduce the pumping work.

In installations when a gravity head is on the jacket water, with the pump lifting the water from a sump to a cooling tower, a constant-capacity pump can be regulated by stopping it if the sump level drops by reason of a reduction in the flow through the jackets. This does reduce the pumping work, but calls for constant attention from the engineer, unless the sump be of such proportions that it will hold two or three hours' discharge without the pump's being operated. Of course, the cooling-tower sump must be of a corresponding capacity.

The type of drive available also influences the choice of pumps. If the engine is driving a factory through belts, it may happen that no electricity is available for the pump motor. It then becomes necessary to drive the pump from the engine by belt, chain, gear or crank and rod. Centrifugal pumps are not recommended for these drives, for the drive pulley on the shaft must be extremely large on the driven pulley or the pump so small as to prevent the belt obtaining a reasonable contact. Belt slapping and chain climbing and binding result when a small pulley or sprocket is used.

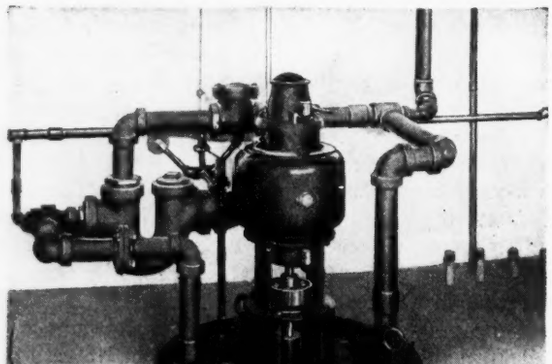
The direct-driven reciprocating pump is preferred for marine installations of moderate capacities. It has the advantage of making the engine more self-contained and reduces the number of auxiliary machines to be attended. Likewise for engines used on portable machinery, such as excavators, the direct-drive pump seems meritorious. But the objection that the engine must



Geared rotary pumps

be shut down for the repair or replacement of so minor a part as a pump valve should not be lost sight of.

Efficiency is seldom considered by the purchaser of a cooling-water pump, yet a considerable saving is made in a year's time if the efficiency of the pump be high. For example, in many situations it is impossible to obtain an average yearly cooling-tower temperature of under 80 deg. If a particular engine runs best with a 130-deg. water-discharge temperature, about 60 lb. of water is needed per horsepower developed by the engine per hour. With a 1,000-hp. engine running 4,000



A vertical centrifugal is self priming

hours per year at a 100 per cent load factor, 60,000 lb. of water is used per hour. If the lift is 60 ft. including pipe friction, the theoretical power used is approximately two horsepower. With a pump of 40 per cent efficiency, the pump would require 4.5 hp., which in a year would entail a power consumption of 18,000 hp.-hr., and with power costing 0.7c. per horsepower-hour it costs $126 to run the pump; with a pump 70 per cent efficiency the saving would be $54 yearly. One would be quite justified in paying a bonus of as much as $200 for the higher efficiency pump.

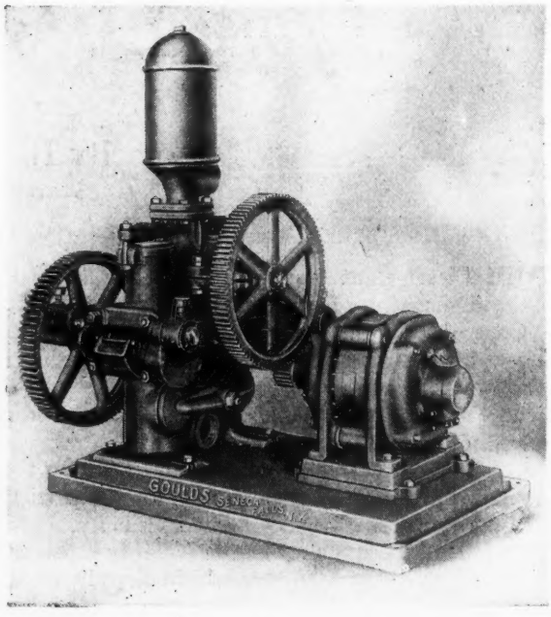
However, if the pump is controlled by a bypass the power consumption will be constant regardless of the engine load. Consequently, a motor-driven triplex pump with a fixed capacity may be more costly to operate even though its efficiency be twice that of a low-efficiency centrifugal pump whose capacity can be regulated by throttling the discharge.

Reliability should never be sacrificed for the sake of a few dollars saved.

The pumps generally employed in handling the cooling water may be separated into triplex, power piston, centrifugal and rotary.

The advantage of the triplex is that it is accessible. Any of the plungers can be removed by simply unshipping the connecting-rod strap. Valves are accessible through renewable cover planes. The efficiency of this type of pump is high, ranging from 60 to 85 per cent, depending on the size. It can be driven by a motor through either gears, belt or chain, or it can be driven from a pulley on the engine shaft.

It is, however, a constant-output machine when under constant-speed conditions. Unless a variable-speed trans-



Horizontal power pump

mission be used or direct current be available for the motor, the water capacity cannot be varied, and to control the amount actually being put through the delivery line, a bypass must be used. As already pointed out, this is objectionable.

When water contains any grit, the valves may wear rapidly. In addition, unless the gears be accurately cut, the machine is noisy in operation. On the other hand, it is self-priming.

Where the Diesel is driving such machinery as a cotton gin, irrigation pump, or oil-field pump, without the interposition of an electrical generator and motor, a pump belt-driven by the engine may be needed. In these installations the power-piston pump is largely employed.

Where a plant is shut down part of each 24 hours, so that pump adjustments can be made, such a unit is

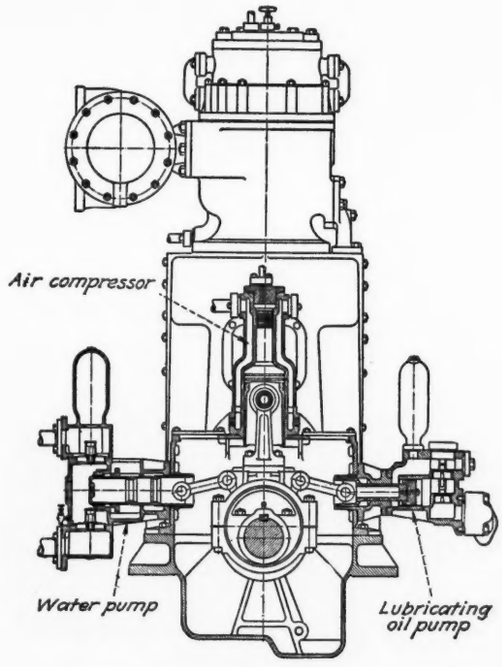
quite satisfactory. It is self-priming, low in price, fairly good as to efficiency and not unduly noisy. As long as the plant is below 300 hp. this type of pump is largely used. In arranging the drive it is well to see that the pulleys are in alignment to insure continuous pump operation.

Many of these power pumps have a plain cast-iron cylinder; it is well, however, to insist upon a removable brass liner. Metal valves are desirable in that, while a little noisy, they will last much longer than rubber valves.

When the engine is small and the head on the pump is low, a rotary, or gear pump, is quite suitable. It has the desirable elements of being valveless, not unduly noisy, easy to connect by gears to a motor, and exceedingly reliable. Its efficiency is low; after the pump is worn, it may not exceed 30 per cent. Heads of more than 60 ft. are not advisable.

By far the most popular pump is the centrifugal. This is due primarily to its many desirable features and to the almost entire absence of objectional features.

The centrifugal pump is low in first cost, is reliable in service and has a low maintenance expense. By the proper choice of the impeller diameter a pump can be



Pump direct connected to the engine

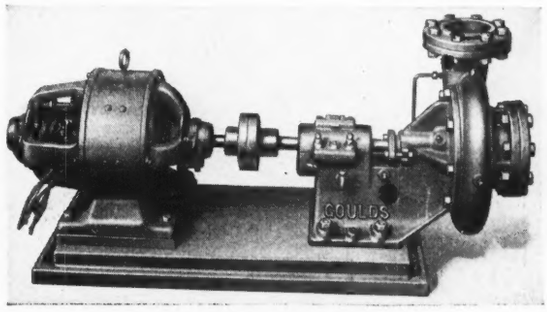
direct connected to a motor of any speed. As the 1,800-r.p.m. motor is not only cheaper but also more efficient than a slow-speed one, the adaptability of the pump to meet any speed requirement reduces the initial investment of the pumping equipment.

One objection to be raised against the centrifugal is that it is not self-priming. If the pumps must actually lift the water, there must be a foot valve and some means for priming the suction line and pump. If the sump can be placed above the floor line, a horizontal pump can be made self-priming or a vertical submerged pump may be used. The latter, while more expensive, is far superior to the horizontal type for all installations where the sump is placed below the pump.

As a location for the cooling-water pump the basement is to be avoided. In fact, no equipment should be placed there, save the lubricating oil tanks. All pumps should be under the operator's eye.

The minimum pipe length should be used, but not to the point where convenience of location is sacrificed.

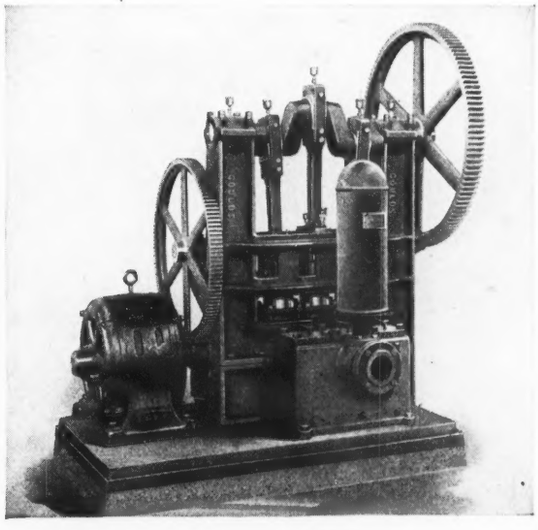
Pump capacity depends upon the size of the engines to be cooled and upon the climatic conditions. If located in a Northern state a summer temperature of 70 deg. is seldom exceeded. Consequently, the quantity of water required is less than in case of a Louisiana plant where the temperature may be around 90 deg. even with a cooling tower. Other localities where the air temperature



A horizontal centrifugal pump

may be as high may show a water temperature of ten degrees less, due to the lower humidity.

At one time engine builders gave but little thought to the subject of pumps. But as it came to be realized that the operation of the plant was not dependent upon the engine's reliability as upon the working of the water pumps and other accessories, pumps suitable for local conditions are being given attention.



Motor driven triplex pump

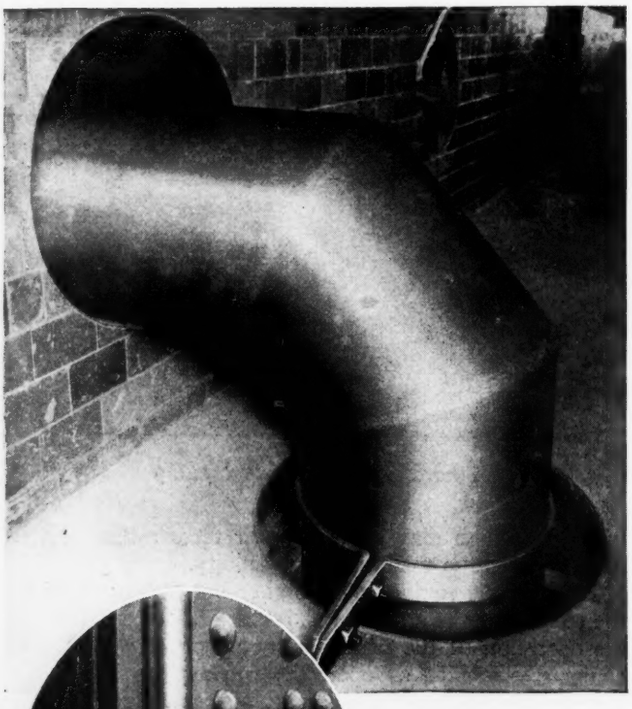
The close regulation of an engine's speed requires that the governor must be sensitive to speed changes, consequently the governor should possess a minimum of internal friction, or otherwise too great a speed change will be reached before the governor overcomes its resistance and moves the control lever. Internal resistance produces a sluggishness which can be given a numerical value by defining it as the proportion which the change in speed necessary to produce the required governor movement bears to the total speed.

Welding Helps Build *the* M

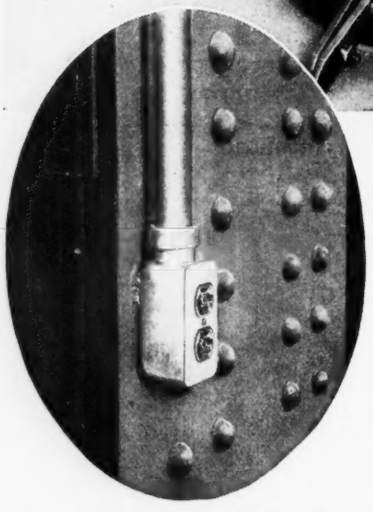
By William Zorn
Welding Foreman
The Detroit Edison Company

In 1925 The Detroit Edison Company was using six electric welding units. Owing to a few unfortunate experiences welding was then looked upon with some distrust and, one might say, was used only when other methods could not be utilized. In the intervening three years these factors have been overcome, and welding is now used in increasing amounts. It has become an indispensable aid to construction and maintenance work. From six welding units in 1925 to 47 units in 1929 marks a forward stride and indicates the confidence welding has attained. Thirty-eight of these units are used on field work, and nine in the shop. The operating force consists of about 50 welders, a double shift working in the fabricating shop. Included in this equipment are two generator units mounted on Fordson tractors, for welding gas mains, and two units installed in trucks have proved their worth on hurry-up jobs. Nearly one hundred oxyacetylene outfits are used in conjunction with this equipment.

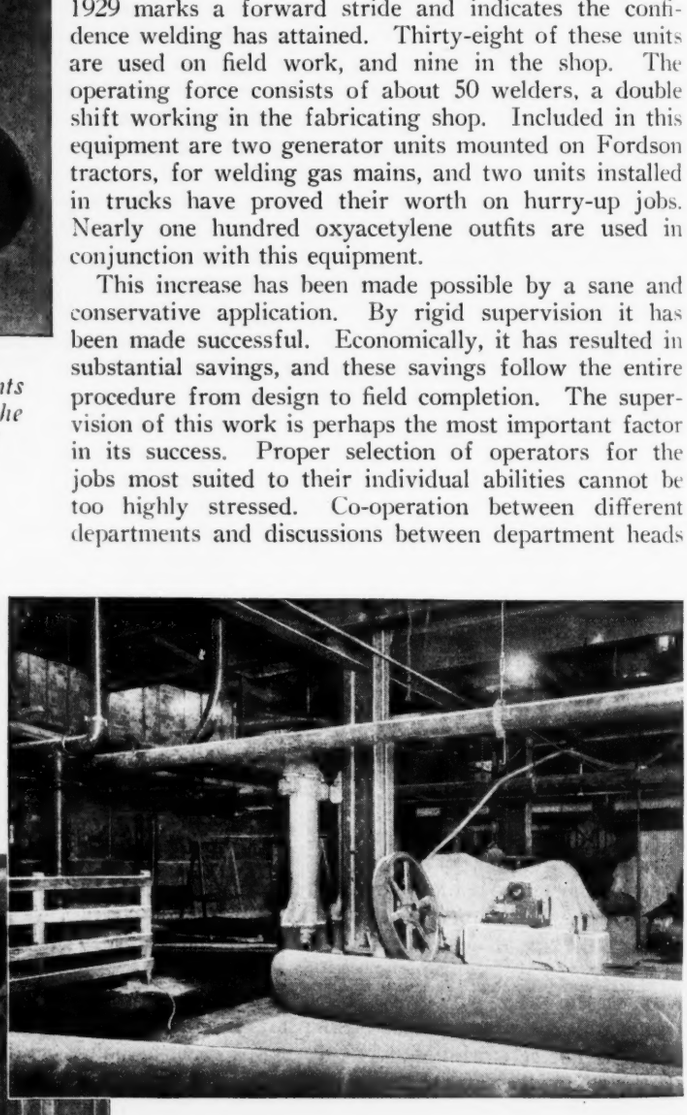
This increase has been made possible by a sane and conservative application. By rigid supervision it has been made successful. Economically, it has resulted in substantial savings, and these savings follow the entire procedure from design to field completion. The supervision of this work is perhaps the most important factor in its success. Proper selection of operators for the jobs most suited to their individual abilities cannot be too highly stressed. Co-operation between different departments and discussions between department heads



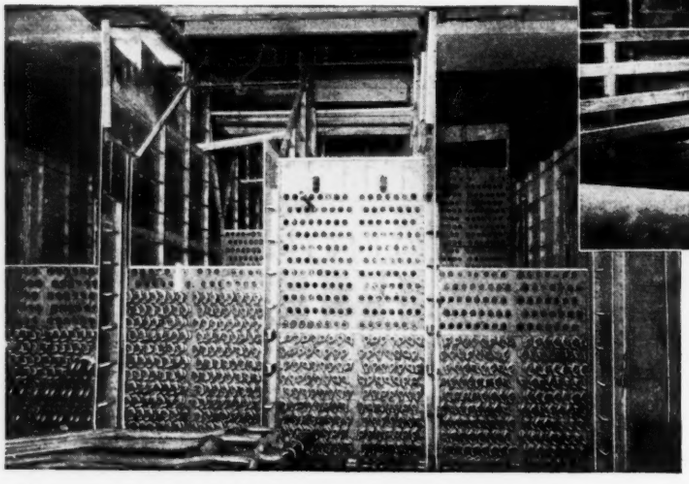
All exhaust vents are welded at the Delray No. 3 plant



Welding electric conduit to the building steel saves time and material



Turbine-room basement of the new Delray plant
Most of the piping shown in this view has been welded



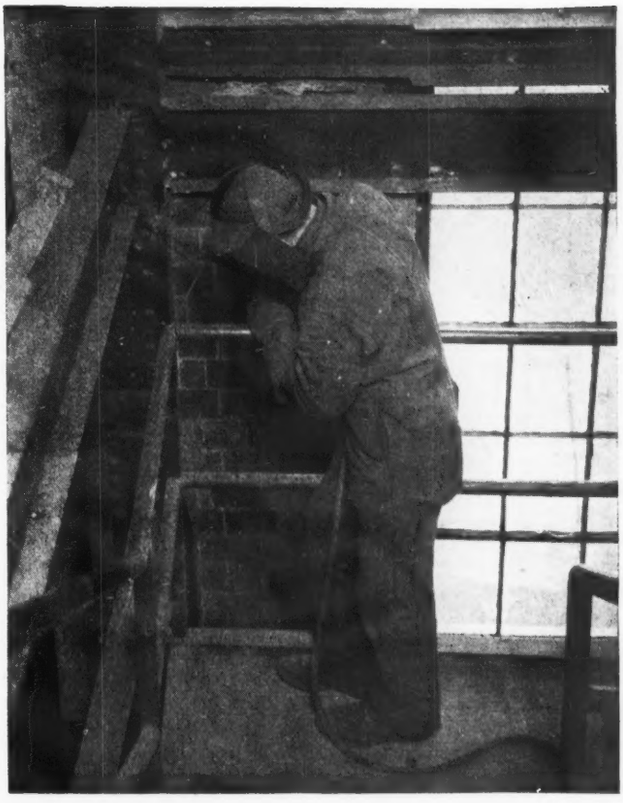
The casings and partitions of this economizer are all welded and also the uptakes leading to and from it

have resulted in a high degree of efficiency in the handling of the problems attending such a rapid growth.

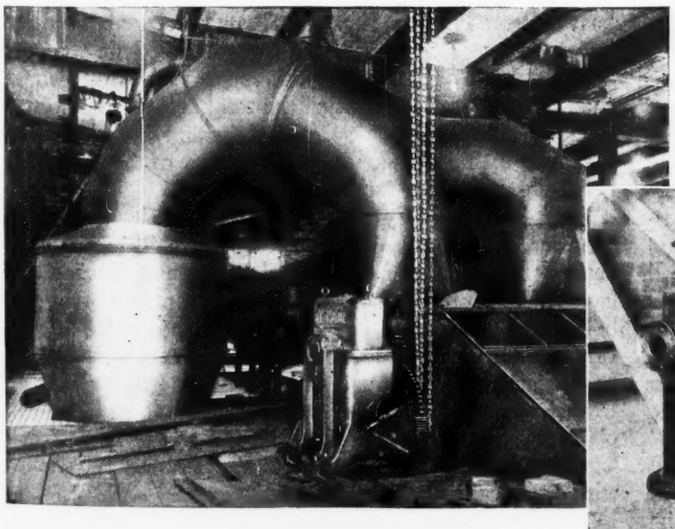
An arc-welded economizer casing, partitions and smoke uptakes were recently completed at the Trenton Channel Plant. This is the first installation we have made of this kind, and it has proved satisfactory both mechanically and economically. By a careful cost check on smoke uptake work, we find a saving of 48 per cent in material and 50 per cent in erection for welding over riveting and calking. This type of economizer and uptake will be installed on all boilers in Delray Power House No. 3.

At the new Delray plant, now under construction, general service water lines, heating-system piping, exhaust vents and compressed-air piping are being welded. At this time 4- 6- 8- and 24-in. diameter pipe have been welded. On the 4- and 6-in. pipe a 45-deg. bevel is used, while on larger sizes a 60-deg. bevel is used, the joint opened $\frac{1}{16}$ in. and butt-welded. No welding on the main steam lines is being done, the highest welded pipe pressure being 100 pounds.

The welding of hand-railing for stairways has reached large proportions, since its adoption two years ago. This railing, of $1\frac{1}{4}$ in. diameter, is received in twenty-foot lengths, laid out by templet and cut with the oxyacetylene torch. The joints are then arc-welded. Owing to the almost universally standard lengths of stairway flights, size of landings, etc., this is a rapid and economical railing. One hand-rail erector, one acetylene cutter and one arc welder will average 200 ft. completely installed in the eight-hour day. The saving over that of using cast-iron fittings and cutting pipe in pipe machines is over 50 per cent.

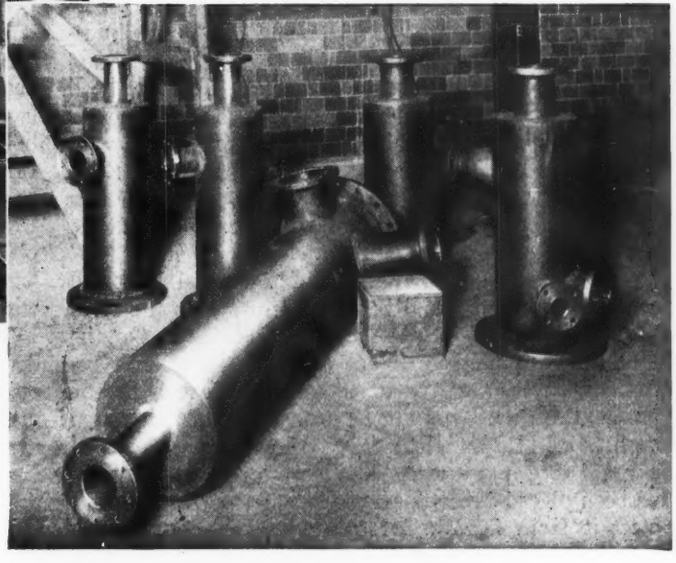


Large savings have been made by welding hand rails and stairway steel



A welded dust collecting system is installed on the coal handling equipment

Welded stage-heater hotwells for the first turbine unit at the Detroit Edison's new plant



Propeller-type wheel has 6 vanes compared to 13 and 14 in the two Francis-type wheels.

Hydro Plant Installs Two Types of Wheels

By George Willock

Engineer
Aktiebolaget Finshyttan, Sweden

Propeller- and Francis-type Wheels *are installed in the Forshuvudforsen hydro-electric plant in Sweden. One is of the Lawaczeck type, of 10,200-hp. capacity and operates at 94 r.p.m. The other two, of the Francis type, are rated 7,700 hp. at 83 r.p.m. All three have practically the same diameter and operate under a 34-ft. head.*

On the Dal River in Sweden, the Forshuvudforsen hydro-electric development has many interesting features. The combination of Francis- and propeller-type units is, in itself, unusual. The low head under which these machines operate and their power output give them physical dimensions that rank with the largest built. It is also of interest that Stora Kopparbergs Bergslags Aktiebolag (Great Copper Mountain Mining Corporation) is the oldest business in existence and dates from 1285.

In general the development is of the usual low-head type, with a masonry and concrete dam across the river and the plant built into one end of the dam. On the top of the dam are four sluice gates of the roller type, each 55.5 ft. long. Two of these gates have a lift of 28 ft. and are used for flood purposes. The other two have lifts of 11.5 and 19.5 ft. respectively and are used for regulating purposes. The two large roller gates have been placed farthest away from the power house to protect it from flood water passing through the gates.

The intake to each wheel is divided into three entrances, each protected by racks to keep out logs and heavy ice. These racks have bars spaced about three inches apart and are set at an angle of 58 deg. to the horizontal. The design of the racks gives a free area equal to about 65 per cent of the total area of the intake. Back of the racks are gates and behind these are fine racks or fish screens, each consisting of sets of fine revolving screens and one fixed screen.

Both horizontal and vertical shaft waterwheels were considered for the project. Low-head vertical units have been installed in both the United States and Europe and have been found to possess many advantages over the horizontal type. For this reason it was decided to use vertical machines. One of the waterwheels is of the Lawaczeck propeller type and the other two are of the Francis type. This combination allows operating the plant at a high over-all efficiency and the propeller unit has a much larger capacity than the Francis type units with practically the same diameter.

The Lawaczeck wheel differs little from the Francis design, the chief difference being that the former has only six vanes and no band around their outer ends, as may be seen in the headpiece. In the two Francis runners there are 13 and 14 vanes respectively and the usual band at the lower end of the buckets. All the buckets, the crown and the outer ring are cast as a unit in the Francis design, but in the Lawaczeck runner the buckets

Equipment in Forshuvudforsen Plant

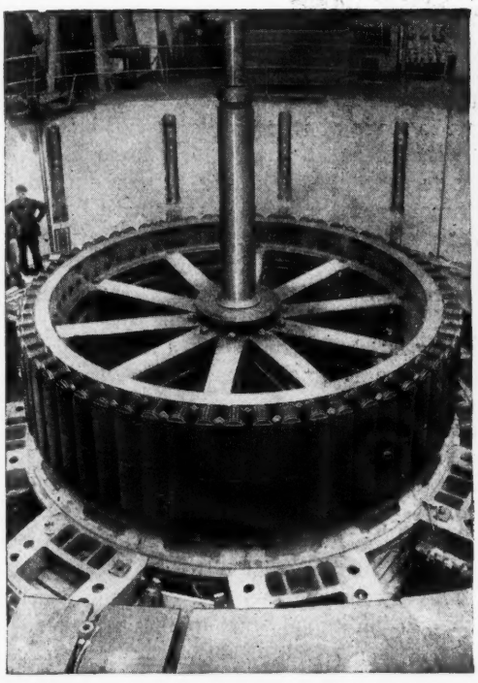


Fig. 1—The generator rotor consists of two cast-steel wheels held together by axial bolts, with the polepieces bolted to the wheels' rims

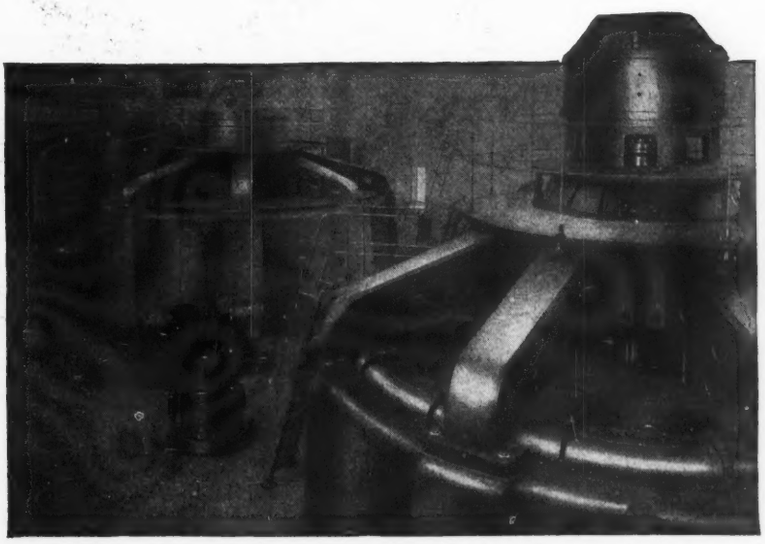


Fig. 3—Generators are wound for 11,000 volts and 50 cycles

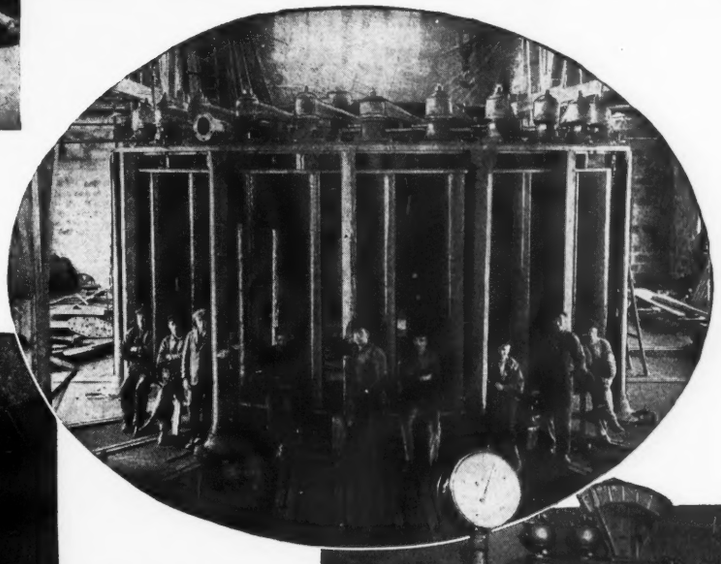


Fig. 4 (Above)—Guide-vane and crown-plate structure for the propeller-type unit

Fig. 2—Inside of the concrete scroll case for one of the units

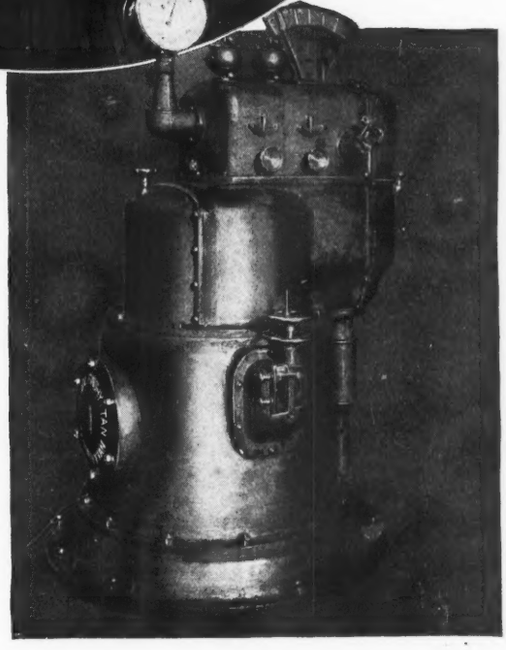


Fig. 5 (Right)—The governor head is driven by a belt from the water-wheel shaft

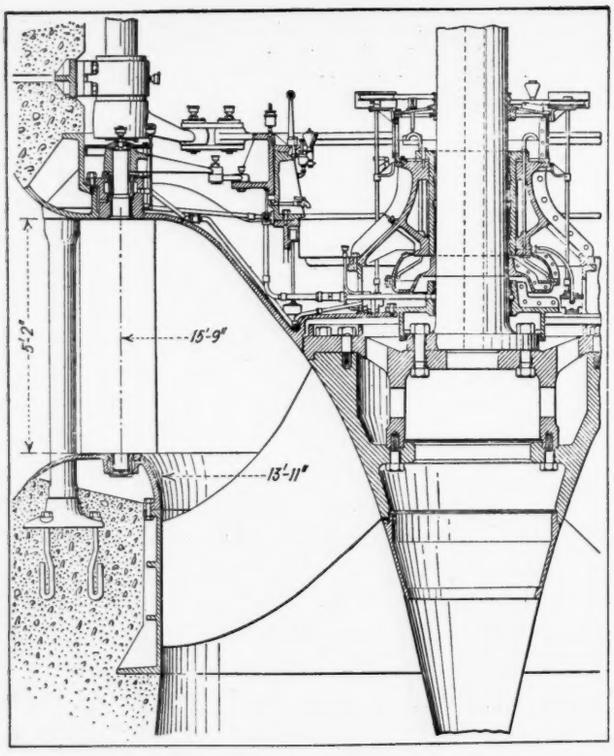


Fig. 6—Cross-section through propeller-type runner and setting

The diameters of the three wheels are practically the same, but the propeller type is rated at 10,200 hp. compared to 7,700 for the Francis type.

are cast separately and bolted to the runner crown. Both types of runners have practically the same diameter, being 13 ft. 7 in. for the propeller design and about one inch larger for the Francis type. The propeller-type wheel operates at 94 r.p.m. and develops 10,200 hp. under a 34-ft. head, and the Francis wheels have a speed of 83 r.p.m. and are rated at 7,700 horsepower.

The guide vanes are of cast steel; the vanes and their spindles are cast as units. On the propeller unit there are 28 guide vanes and these are supported in ball bearings to keep the power at a minimum to operate them. The crown plate is made of iron and is cast in sections. It differs from that used on the Francis units in that it is made very deep, as shown in Fig. 6, to reduce the weight of the runner and the load on the thrust bearing and also to reduce the wetted surface of the runner, which improves the efficiency of the wheel.

Governing equipment for the Lawaczeck turbine is shown in Fig. 7. The pendulum (flyball governor) is shown in the upper left-hand corner and the main valve, controlling the oil supply to the servomotor, is in the lower right-hand corner. These two are connected by the floating lever, which is provided with the usual restoring gear. This gear, as the piston of the servomotor moves in or out, restores the main valve to its neutral position. With this type of governor, however, the speed would not be the same at full as at partial load, and an addition to the usual restoring mechanism is provided. This mechanism, as the governor comes into action, gives an additional shift to the fulcrum of the floating lever, so as to restore the sleeve of the fly-

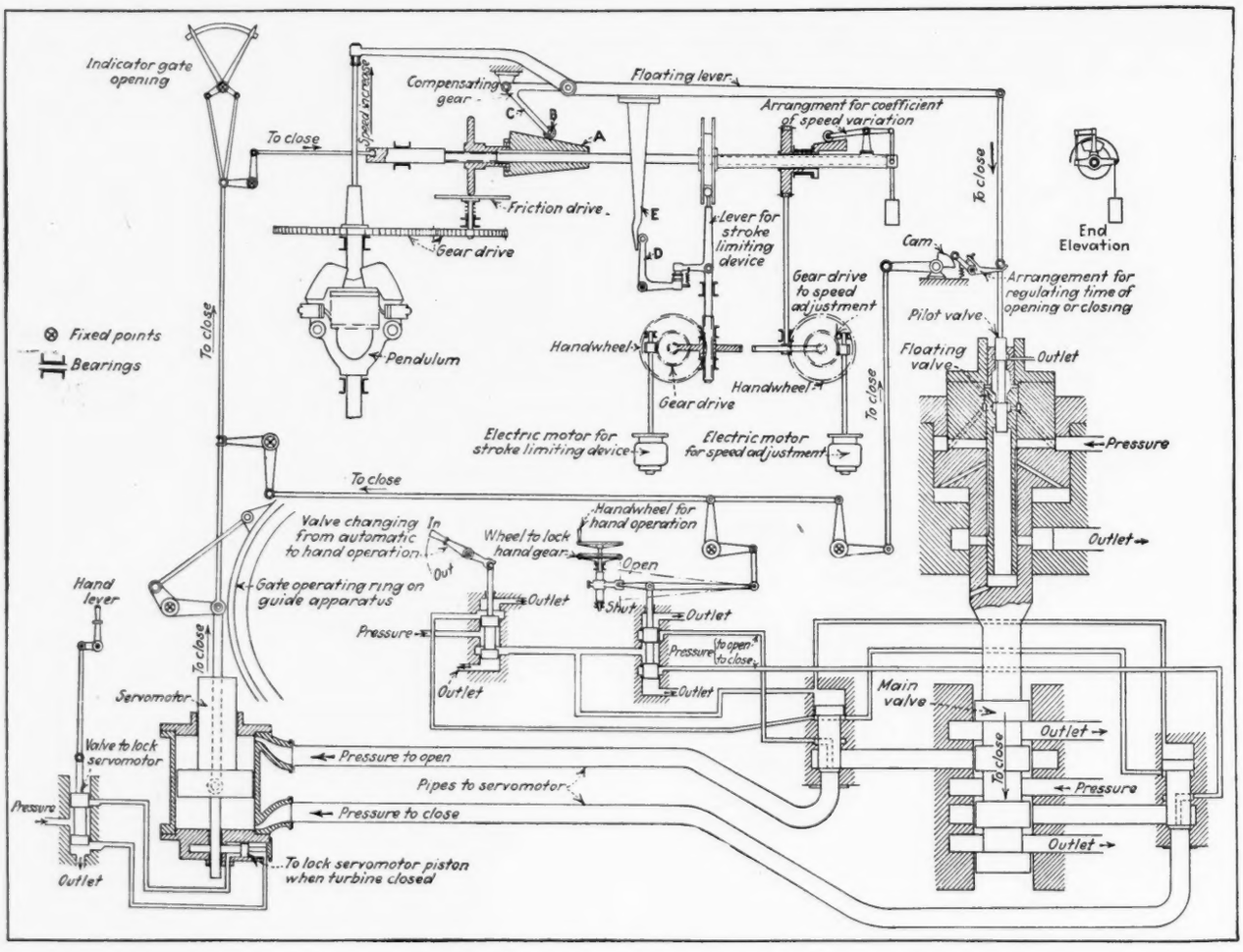


Fig. 7—Diagram of governor operating mechanism

balls to its mid-position at the same time that the main valve is returned to its mid-position.

This compensating gear consists of a friction wheel and disk. When the speed of the unit is normal the friction wheel is central with the disk that drives it, and is therefore at rest. As soon as the governor acts the wheel is raised above or below the center of the disk and is rotated accordingly in one direction or the other. As it rotates, it operates a screw and moves the cone *A* backward or forward, and in this way the roller *B* is shifted along the cone. Lever *C* is accordingly moved in one direction or the other, and in turn shifts the fulcrum of the floating lever so that the governor sleeve is returned to its mid-position. At the same time an additional restoring movement by a second floating lever returns the friction wheel to the center of the disk, and the turbine runs at the same speed as at partial load as it does at full load.

Gate Opening Can Be Limited

The gate opening can be limited at will by hand or from the switchboard by means of an electric motor. This acts through the mechanism shown, so that the lever *D* prevents the arm *E* from moving more than a certain distance, thereby retarding the action of the floating lever and preventing the main valve from opening beyond a predetermined amount. The speed of the unit can also be varied at will either by hand or electrically as indicated.

Arrangements are made for hand operation of the unit and for a small locking gear that locks the servomotor piston when the turbine is shut down. The whole of this mechanism is inclosed in the dustproof case shown in Fig. 5.

Guarantees have been made that the speed variation will not exceed the following values:

± 25 per cent load change	∓ 5 per cent speed variation
± 50 per cent load change	∓ 13 per cent speed variation
— 100 per cent load change	+ 32 per cent speed variation

The governor head is driven by a belt from the turbine shaft, and the triple-gear pump, which supplies the oil required to operate the servomotor, is driven by an electric motor. The governor case and oil pump with air vessel and motor are placed on the generator floor, while the oil reservoir is embedded in this floor immediately under the oil pump, and the servomotor is placed under the generator floor.

The oil pump with motor, air vessel and oil reservoir is shown in Fig. 8. The teeth of the pump gears are of special form to insure silent running and make the pump's operation independent of the oil used. The oil level in the pressure tank is kept constant by means of a loaded valve. As the pump is run continuously, the surplus oil is bypassed through the loaded valve to the oil reservoir.

The propeller-type unit has not yet been tested at site, and as these tests will not be carried out before this summer no results can be given. In the table the maximum efficiency given is that calculated from tests on a model of the actual runner and is obtained at about 9,500-hp. load. The water measurements at site will be made by current meters in the usual way when the unit is tested.

On the large unit the generator is rated at 9,000 kva. at 0.75 power factor, and is designed for three-phase 11,000 volts and 50 cycles. The generator is of the vertical type arranged for direct connection to the waterwheel and is provided with two guide and one thrust bearing. The thrust bearing is dimensioned to carry the total rotating load of the generator and exciter rotor, as well as the weight of the turbine runner and the unbalanced hydraulic thrust.

COMPARISON OF THE PROPELLER AND FRANCIS TYPE RUNNERS

Unit No.	Type	Rating, Horsepower	Speed, R.p.m.	Specific Speed	Runner Diameter In.	Buckets in Runners	Runner Weight, Tons	No. of Guide Vanes	Maximum Eff., Per Cent
1	Francis	7,700	83	90	164	13	24	20	85
2	Francis	7,700	83	90	164	14	18.7	20	88
3	Lawaczeck	10,200	94	119	163	6	24	28	92*

*Calculated from tests results obtained from a model of the runner.

The rotor consists of two identical wheels held together by axial bolts, Fig. 1, each wheel being provided with a hub, arms and magnet ring all cast in one piece. The hub is secured to the shaft by keys and shrink rings. The wheels are spaced from each other to obtain a radial ventilating duct running between the rings and through the polepieces. This duct allows the cooling air to flow through the rotor to the stator. The polepieces are made of cast steel and are held to the rotor ring by steel bolts. The field coils are wound from strip copper on edge. Impregnated paper is used for insulation between turns.

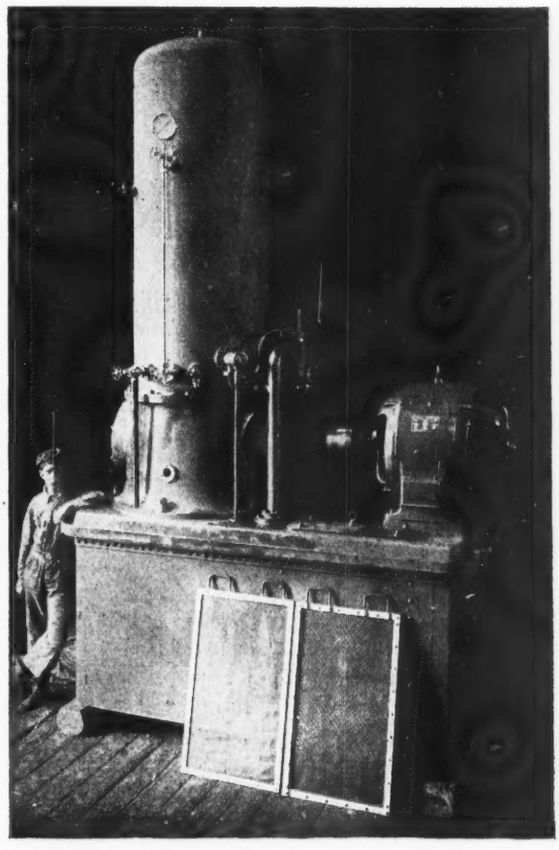


Fig. 8—Motor-driven governor pump with oil and air pressure reservoir

The Lawaczeck wheel was built by the Aktiebolaget Finshyttan and the generator for the unit by Allmänna Svenska Elektriska Aktiebolag. One of the Francis wheels was supplied by Verkstaden and the other by Nydqvist & Holm and the generators by Elektriska Aktiebolaget A.E.G. All these companies are located in Sweden.

Benson Boiler versus Loeffler Boiler

A Reply to Doctor Loeffler

By H. W. Queisser
Junior Test Engineer
Siemens-Schuckertwerke, Berlin, Germany

In Power, *March 19 and 26, Doctor Loeffler described the Loeffler "steam pumping" boiler wherein steam is pumped through a separately fired superheater and then through an unfired bubbling drum partly full of water. He argued its superiority over all other types for high-pressure steam generation. Mr. Queisser replies, defending the Benson "Critical-pressure" system. Readers familiar with other types of high-pressure boilers, particularly the normal drum types widely used in America, are invited to join the discussion.*

IT WAS a good idea for *Power* to present Doctor Loeffler's articles (March 19 and 26) on the generation and use of steam at high pressures and temperatures and to invite interested readers to join in a general discussion on this subject. The writer of the present article gladly follows this invitation by contributing an answer which will especially deal with the Benson boiler.

Both the Benson and the Loeffler boiler are radically different from the normal-type boilers now in use for pressures up to 400 to 600 lb. Some other high-pressure boilers, especially in America, are substantially of the same design as the water-tube boilers for moderate pressures.

We agree with Doctor Loeffler so far as we also believe that for highest pressures, say above 1,000 lb., the normal type boiler will not be applied with success, but that future development will rather trend toward a special type of boiler better adapted to the requirements of high-pressure steam generation.

The principle of the Benson process is likely to be known to *Power* readers by this time from several publications in the past: *Power*, May 22, May 29, 1923; March 18, 1924; Feb. 3, 1925; May 31, 1927, and *Power Plant Engineering*, July 1, 1928.

Steam generation takes place in the neighborhood of the critical point (3,200 lb. per sq.in., 706 deg. F.), where the specific volume of the dry saturated steam exactly equals that of the liquid, so that the water is converted into steam as a whole without steam bubbles being formed. The water circulation is entirely artificial, the pressure being maintained only by the feed-pump. The boiler proper consists simply of tubes through which the water is forced and in which its temperature gradually increases until the critical temperature is reached, the remainder of the heating surface acting as superheater.

Nowhere in the boiler exists a mixture of water and steam, so that boiler drums and return tubes can be dispensed with. The steam output per tube is limited only by the tube diameter and the velocity allowed in the tubes. The number of rows in parallel is determined in each case according to the desired total output.

As a matter of fact, the Benson process may be carried out with any liquid and its vapor, water and steam merely being the most practical working medium at the present time.

From Doctor Loeffler's article readers could be misled to the conclusion that Doctor Havlicek had first pointed out this system of steam generation. What Doctor Havlicek, however, published sixteen years ago, was a merely theoretical investigation on the thermal efficiency of the Carnot cycle as affected by the initial steam pressure and temperature. Naturally, this comparison of initial pressures was extended up to the critical pressure, which has long been a common concept of physicists, but nothing was said in that article about actual generation of steam at the critical pressure.

The first man really to develop a practical process of generating steam at the critical state was Mark Benson, who took out his first British patents in May, 1922.

The extremely high critical pressure of water, which amounts to 3,200 lb., makes the Benson boiler rank foremost in high-pressure steam generation.

Doctor Loeffler limits the pressure of his boiler to the order of 1,500 to 2,000 lb., claiming that there should be no thermal gain above this pressure. If one merely looks at the adiabatic heat drop available at a given back pressure, it is true that there is a maximum, say around 1,600 lb., but it will be easily realized from a glance at a Mollier chart that above this pressure the total heat input per pound of steam decreases much more rapidly than the adiabatic heat drop available, so that the thermal efficiency keeps on increasing up to much higher initial pressures, say around 2,500 lb., depending on the back pressure.

Another advantage of the higher steam pressure in the Benson boiler is the better heat transfer between the tube walls and the water or steam, respectively. This is due to the higher density of high-pressure steam and to the greater velocity that is customary in the tubes of the Benson boiler.

This better heat transfer has two good effects: First, it reduces the heating surface required for a given output. Secondly, it brings the temperature of the tube-walls much closer to that of the liquid or steam inside, so that a considerably higher superheat may be allowed without endangering the tubes.

In the case of the Loeffler boiler we have, so to speak, a separately fired superheater. The tubes that are exposed to the radiant heat, are filled with superheated

steam. In the Benson boiler, however, the tubes forming the radiant heating surface in the combustion chamber are filled with water, thus giving a safer temperature of the tube walls and a better temperature difference for radiation.

On the other hand, the superheater tubes of the Benson boiler are protected against direct radiation, which, in addition to the smaller temperature difference between walls and steam, guarantees reliable operation.

The fact that the steam is generated at a pressure more or less above that at the turbine throttle is immaterial, because the heat content remains constant anyway and the increase of entropy means very little in this range of pressure, as can be seen easily from a Mollier chart. The advantage of generating steam at as high as 3,200 lb.—even if the turbine uses only 2,500 or 2,000 lb. or less—is a rather practical one, namely, the avoidance of any drums and return tubes and all the troubles experienced from evaporation and ebullition in the case of natural circulation at pressures below the critical. Thus the heating surface of a Benson boiler can be located from the viewpoint of ideal combustion and gas flow without any restrictive considerations as to the placing of drums or return tubes.

Doctor Loeffler points out in his article that any unequal flow of the water or any difference in the heat input to the tubes should act harmfully in the Benson boiler. It is true, of course, that care must be taken to secure a uniform distribution of the flow of water as well as of the heat input from the fire. This is mainly a question of design and in the actual Benson installations this uniformity has been materialized fairly well. Moreover, the most recent designs for new installations show some more improvements along this line, one of the main features being the helically wound (instead of vertical) coil around the combustion chamber through which all parallel rows should be affected in the same way by any possible fluctuation of the powdered coal flame or by an uneven firebed in the case of stokers.

Furthermore, the objection is heard sometimes, that because of the relatively small water storage capacity the

> *"Another advantage of the higher steam pressure in the Benson boiler is the better heat transfer between the tube walls and the water or steam, respectively. This is due to the higher density of the high-pressure steam and to the great velocity."*

variations of pressure would be too high if the load should change suddenly. These predictions have failed to materialize, because with a good automatic or push-button control, in connection with a flexible firing method, one can rapidly follow the fluctuations and easily restore the pressure. On the other hand, the lack of large water storage is an advantage of the Benson boiler in that any possible rupture would be harmless.

Another point about which wrong ideas seem to circulate, is the velocity of the water in the tubes of the Benson boiler and the power required of the feed pump. Doctor Loeffler states in his article in *Power* that high velocities would be impracticable in the Benson boiler because of the large resultant power required of the feed pump. If we consider, however, that in most cases the steam has to be throttled anyway from the critical pressure to that at the entrance to the turbine and that, moreover, in this range of pressure several hundred pounds means but a small percentage of the total, it will be realized easily that the Benson boiler is the very boiler for high velocities, which is one reason for the good heat transfer that has been mentioned already.

As far as the power input to the feed pump is concerned, one must not be misled by the high figure of the critical pressure *per se*. He should rather keep in mind that the total heat content as taken from the steam tables

> *"The advantages of Loeffler's drum are evident, but judging the system as a whole, one must not forget that there is also an economizer in the setting of the Loeffler boiler, the tubes of which are endangered by possible scale deposits."*

or from a Mollier chart, includes the energy added by the fuel plus that added by the feed pump, so that the energy input to the water by the feed pump may be subtracted from the number of B.t.u. that have to be delivered by the boiler proper. Moreover, most of the losses of the feed pump will be returned as internal energy in the water.

As compared with the Loeffler steam pump especially, the Benson feed pump has the advantage of pumping a much smaller volume per pound of steam delivered, not only because of the higher density, but also because the amount of steam that has to be circulated through the Loeffler steam pump is about three to four times as much as the net output.

As far as the feed water is concerned, Doctor Loeffler compares the drumless Benson boiler with the large vaporizing drum of his boiler, pointing out that no danger should be feared from impure feed water in the Loeffler boiler. The advantages of Loeffler's drum without metal heating surface are evident, but, judging the system as a whole, one must not forget that there is also an economizer in the setting of the Loeffler boiler, the tubes of which are endangered by possible scale deposits.

In the Benson boiler no hard scale is formed because of the forced circulation and because of the absence of any steam bubbles. The impurities rather collect as dirt and mud and are easily removed by routine blowdowns from the different rows of tubes.

Benson boilers have now been running for years in Germany, and many prominent American engineers have seen them in operation. A new boiler of 45 tons per hour capacity is nearing completion, and work has been started on a unit of 100 tons per hour.

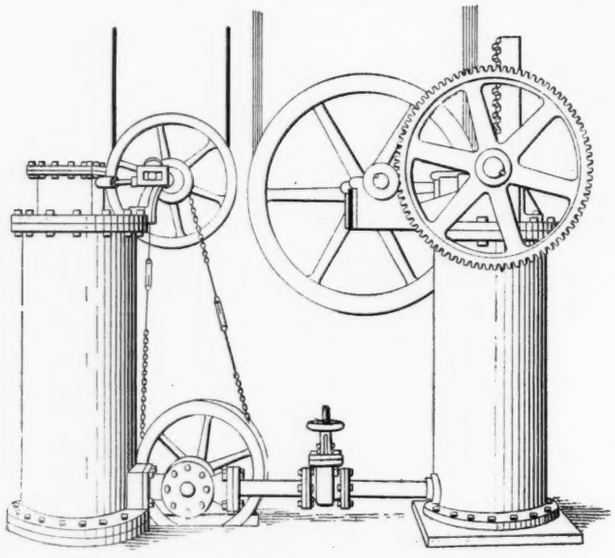
It will be understood that much research and test work was required in order to develop commercially such an outstanding process as the Benson process. This has been done in recent years by the *Siemens-Schuckertwerke, A. G.*, Berlin, Germany, and although much remains to be done, one can say already that the Benson boiler has reached a state of development which is likely to open a new era in high-pressure steam generation.

Right Out of the Plant

Otto Atmospheric Gas Engine Wanted by the U. S. National Museum

ON PAGE 675 of the April 23 number reference is made to the original Otto engine and the desire of the National Museum at Washington, D. C., to have one.

There were quite a number of these engines in operation in the Centennial Exposition held in Philadelphia in 1876. I had just graduated from Swarthmore College as an engineer and I spent many an hour watching



Elevator machine patterned after the original Otto engine

those machines. They were beautifully made. They had large flywheels, and everything had a most painstaking finish. I think there were some six or eight, perhaps more, of these engines in the exhibit, and they were all piped up with the city illuminating gas.

The reason I remember about them is because I got an idea from the machine for an elevator. The accompanying illustration, or that part of it on the right, would be a fair copy of the machine.

In my machine I used a rack and pinion, multiplying the motion of the rack in the way shown. We made several of these machines on this plan for running dumbwaiters in apartment houses in New York City, and they worked fine. The rope wheel on this machine was the flywheel of the engine.

In the article referred to it was stated that the engine was driven by the weight of the piston dropping down, but it was my impression that the impulse came from the shooting of the piston up.

Perhaps if a search were made through Philadelphia, one of these machines might be found, as the Otto Engine Works was afterward established there, where they manufactured large numbers of these machines, later improved. Their plant was on Walnut Street, at the western end of the bridge over the Schuylkill River.

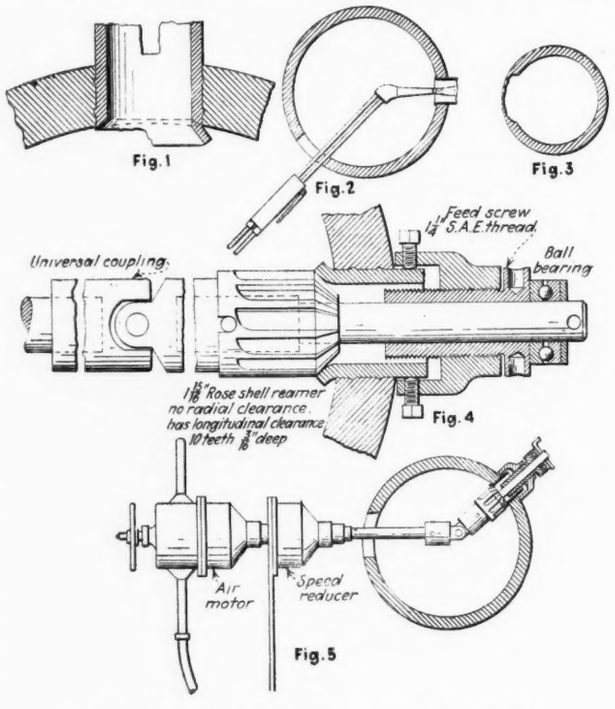
Coatesville, Pa. WM. H. RIDGWAY,
The Craig Ridgway & Son Company.

Use of the Torch in Changing Superheater Tubes

CHANGING the tubes of superheaters that have the loop ends expanded into a manifold is, in some installations, rather difficult. If there is an expert oxy-acetylene torch operator available, then the quickest way is to cut each end of the loop fairly close to the header (about $\frac{1}{2}$ in. away) so that the loop can be removed. The next thing is to remove the expanded ends, and it is for this that skill with the torch is required.

To cut a groove in one side of the tube without damaging the surface of the hole in which the tube is expanded requires care and experience in handling a torch. What makes it possible to cut a tube in this way is the fact that it is to a certain extent insulated from the header by the lamination that separates them. This allows the tube to heat more quickly than the surface of the hole.

First the bell of the tube is cut away as in Fig. 1. Then, using a torch of suitable shape (one with a 45-deg. head may be right), the groove is cut on one side (Figs. 2 and 3) until the last remaining particle of the tube blows away from the seat, at one spot. The little that



How the torch and special tools are used

now remains in the groove will not prevent the easy driving out of the tube end. It will be seen by Fig. 3 that there is a gradual burning away of the tube surface until enough has been removed.

For such tubes as cannot be reached with the torch or when there is no reliable torch operator available, I have designed the tool shown in Fig. 4. The drill, or reamer, is $\frac{1}{16}$ in. smaller than the tube hole. This is a slower process than cutting out with a torch, but where only a few tubes have to be removed it is fast enough.

The tube is first cut off about one-half inch away from the header by an internal tube cutter or by a torch; the use of the latter here requires only ordinary care. The drill is mounted as shown in Figs. 4 and 5. To reduce the speed sufficiently the gear case of an old air motor was fitted up as shown in Fig. 5. This reducing gear has proved useful for other purposes, reaming large holes, etc., where a slow-speed motor was not available.

Long Beach, Calif. E. J. JORDAN.

Method of Tempering Coal in the Furnace

IN THE Nov. 6, 1928, number of *Power* L. W. Hayward had an interesting article on the "Methods of Tempering Coal for Traveling Grate Stokers." The addition of the moisture often improves the burning quality of the coal to such an extent that a saving of from 2 to 10 per cent in furnace efficiency results.

The moisture added to the coal reduces the caking tendency through the bursting action of the escaping steam, thus preventing formation of bunches or large cakes of coal, reducing ashpit loss and increasing the CO_2, which reduces the stack loss.

The real effect of moisture, however, is not so great owing to the fact that the moisture is evaporated at low temperature, while the caking of the coal takes place only at high temperatures. Therefore it would seem that the moisture is evaporated before it can do much good.

The bursting action in the lumps can be attained if to the bituminous coal some fuel with a considerable quantity of volatile matter be added, especially that with low temperature of distillation and ignition; for instance, sawdust. By adding this fuel the burning temperature will not be reduced and stack loss will not increase. The volatiles are distilled off at comparatively high temperatures, close to the temperature at which the caking of the coal takes place, therefore the bursting action in this case should be greater than by using moisture.

The volatiles having low ignition temperatures are not only easily inflammable by themselves, but also ignite the volatiles in the bituminous coal and even the heavy hydrocarbons which require high temperatures for ignition. Subsequently, there will be no caking into bunches or lumps and the burning will be smokeless, as the fuel added improves the burning of the volatile matter in the coal, while the coal itself prevents the volatile matter escaping too readily from the added fuel.

The foregoing statement was verified in 1922-23 in one of the boiler plants of Suchan Coal Mines near Vladivostok. In this plant there were four hand-fired boilers, two being of the locomotive type and two of the locomobile type.

The daily consumption of coal was four cars of five tons each, or a total of twenty tons. At my request, instead of four cars of coal the boiler room received two cars of coal and two cars of sawdust, and this quantity proved to be quite sufficient.

Thus, two cars of sawdust, weighing less than three tons, were substituted for two cars of coal weighing ten tons with calorific value of about 12,400 B.t.u. With this combination of fuels the clinker formation on the grates was avoided and the necessity of cleaning boiler tubes was lessened.

Under these circumstances it would be only right to pay 3½ times as much for the sawdust as for the good coal. However, at the Suchan Mines, the cost of sawdust, as well as the delivery of it from the sawmill, 16 miles distant, was a small item, thus the practical economy attained reached 50 per cent. Taking into consideration the calorific value of the sawdust, the general economy of fuel was about 46.5 per cent.

There are many other materials that possess nearly the same virtues as sawdust, and should they be applied for the purpose of tempering coal it would be possible to pay high prices for them and still have profit.

Sometimes good results might be obtained by adding suitable brown coal screenings for which, however, it would be possible to pay more than it is worth, on a basis of its calorific value.

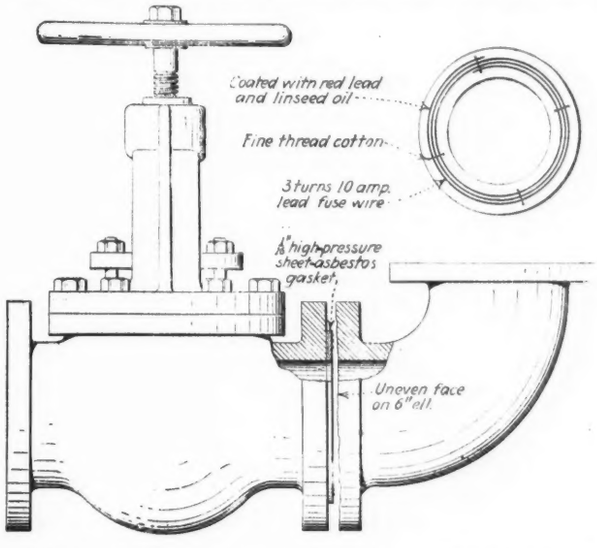
This method of tempering coal in the furnace is especially advantageous wherever the draft is somewhat limited.

M. KOCHERJINSKY,
Harbin, China. Bryner & Company.

Improvised Pipe-Flange Gasket

ABOUT a year ago I experienced some difficulty in making up a 6-in. ell to a non-return valve and the sketch shows how the difficulty was successfully overcome.

Having tried several gaskets none of which made a tight joint, I made an examination and found the face of the ell had not been faced off true. Not having the time or the necessary facilities to correct the face of the ell, I tried an experiment which proved successful. A regular high-pressure sheet-asbestos gasket $\frac{1}{16}$ in. thick was prepared as follows: Three turns of 10-ampere lead fuse wire was laid on one side and held down near the outer edge with fine thread (cotton) at about four points as shown. The side with the fuse wire was painted with a mixture of red lead and linseed oil, then the gasket was suspended and inserted between the flanges with the fuse wire toward the face of the ell. The joint was pulled up in the usual manner and a small amount of steam turned on for about fifteen minutes, allowing the job to get thoroughly heated without much pressure.


Coated with red lead and linseed oil
Fine thread cotton
3 turns 10 amp. lead fuse wire
1/16" high-pressure sheet-asbestos gasket
Uneven face on 6" ell

Sheet asbestos gasket reinforced with three turns of lead wire

This job has now been in service for about a year carrying 190 lb. pressure with about 100 deg. superheat and has remained perfectly tight. R. J. NAGLE.

Westmont, N. J.

Josiah Hornblower

THE Foreword "Josiah Hornblower," in the April 30 number mentions that the University of Edinburgh was the place where James Watt made his discovery while working as an instrument maker. This is not correct, because Watt made his discovery at the University of Glasgow, where his skill as an instrument maker had been recognized for some time.

Watt left Glasgow in 1755 to study instrument making in London and returned to Glasgow in 1757. His intentions to start business in Glasgow as a master instrument maker were frustrated by a local body called the Incorporation of Hammermen, who refused to recognize his practically new trade and denied him the right to practice anywhere in the city.

Fortunately, he was engaged by the University of Glasgow to repair some astronomical instruments and his skill quickly attracted the attention of the professors. Recognizing that he could not work in the city, they built a special workshop for him inside the University of Glasgow and gave him protection from the Incorporation of Hammermen.

During the next six years Watt studied the theory of steam engines. He found out that the University of Glasgow possessed a model of a Newcomen engine, which at that time was in London for repairs and arrangements were made to return the engine to Glasgow.

In the year 1763 the Newcomen model was returned to the University of Glasgow, and while repairing this model, Watt made his discovery which helped to solve the difficulties of Newcomen, Papin, Savery and others.

Cumberland, Md. BART J. LYONS.

[I stand corrected.—F. R. Low.]

The Maintenance of Air Compressors

AN AIR compressor forms an indispensable part of every oil-engine plant for supplying either the starting and fuel-injection air or starting air only. The usual form of air compressor used for this work is a two- or three-stage machine driven either from the engine crankshaft or by an independent motor.

One of the important things in operating a compressor of this kind is to watch the readings on the pressure gages between the stages, for if any unusual change takes place it should be investigated at once, as it denotes leaky valves or piston rings either in that stage or the one above it. Provided the readings of these pressure gages do not vary greatly from the pressures shown when the compressor was first started, the valves and piston rings can be considered to be in reasonably good condition. Leaky valves and piston rings may be caused by the air containing abrasive impurities. This makes it advisable to fit filters over the air intake.

In some cases the valves and piston rings in the low-pressure cylinder may be unaffected, but those in the intermediate- and high-pressure cylinders badly scored. The cause of this is not impurities in the air as it enters the cylinders, but impurities collected in the compressor. Steel and iron parts may rust owing to moisture collected from the air, the loose rust being carried away with the air and scoring the metal surfaces in the succeeding stages.

A place where rust is likely is in steel purge chambers between the stages. Water collects in these and causes rusting. The best remedy is to paint the interior of the chambers with a good metallic enamel.

The proper lubrication of air compressors is most important. The use of a poor oil may cause considerable trouble from excessive carbon formation in the cylinders and intercoolers. In some cases, in order to reduce the amount of carbon formed, lubrication with soapy water is adopted after the compressor has been started, oil lubrication being reverted to about one hour before stopping, to avoid trouble from water being left in the compressor. The soapy solution is made from about one gallon of soft water to which two pounds of soft soap has been added and dissolved. While this solution is being fed, the drain cocks should be opened frequently to drain away any water and sludge.

Intercooler coils occasionally fail by bursting. This is sometimes due to an oil explosion in the coils and the reduction in their strength by erosion and corrosion. These coils should be inspected every six months, the wear in the coil usually being calculated by its weight. The coil is weighed at each inspection, and when a weight reduction of 30 per cent is reached the coil is discarded. The coil is of course cleaned before weighing.

By avoiding overheating the compressor, using lubricant sparingly and removing solid impurities from the air by filtering, the life of these coils can be lengthened and the liability to failure by bursting materially reduced.

Brentford, England W. E. WARNER.

Going Over the Chief's Head

GOING over the chief's head seems to be, as always, the big stumbling block to the young and ambitious engineer. The question is an old one, and to my mind *Power's* answers, so far, are about all one could expect, bar past recollections. But I feel the question is one deserving more attention.

If it were not for enthusiasm and interest among our engineers, this country would not be what it is today. It has been said that enthusiasm is the father to all ideas. But, unfortunately, all ideas are not good—in their application. And that's the problem. Here is about the way it works out. The engineer gets a really worth-while idea. It has been approved by some leading technical publication, vouched for by the local chapter. The savings are reckoned in four places, which would pay off the total indebtedness in a year or so. Yet the chief engineer refuses to entertain the idea. There is friction, and probably the assistant loses his job.

Most chiefs know full well their immediate needs concerning operation and occasionally entertain dreams of the future; most are open-minded. It is proper to confer with the chief when considering changes in equipment. Possibly he will rule against you. He can't and will not tell you that he secretly knows the corporation plans to liquidate, to sell out, to consolidate, to build anew, or to buy all its power—that the whole power situation is now being hashed over, that a new highly recommended engineer now has his application in; that the gain you expect to show is totally offset by certain velvet rebates which are Greek to you, that the directors are—well, in short, you are not in possession of all the facts.

And so in view of the foregoing, if you are positive that the chief is holding out on you, that he can't speak with authority, go to the next in line who can.

H. A. LIVINGSTON,
Chief operating engineer,
Holyoke Power & Electric Company.
Holyoke, Mass.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

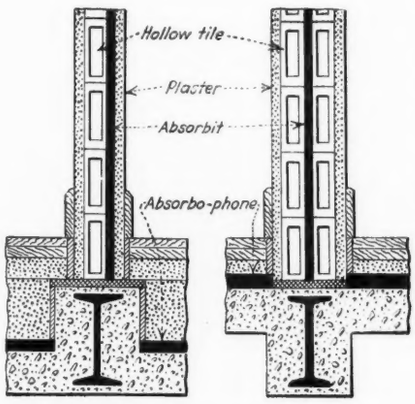


Fig. 1—Soundproofing insulation applied to walls

Wall and Floor Soundproofing Material

TO RESTRICT and overcome the transmission of sound waves through a partition wall or floor, the Korfund Company, 235 East 42nd St., New York City, has developed two types of material—"Absorbit" for wall insulation and "Absorbo-Phone" for floor insulation.

Absorbit is made of layers of fibrous material with an air spacer and is impregnated with asphaltum. The layers are laminated together to $\frac{3}{4}$ in. thickness and are made in standard plate size 24x48 in. They are readily cut to any desired shape, and according to the manufacturer, they are non-porous, odorless, impervious to moisture, and will not crack or buckle. The plates may be installed on existing walls or between walls, as shown in Fig. 1. They can be fastened to any kind of even surface by a mastic, and the surface of the plates is such that plaster can be applied directly to it.

To soundproof a floor it is necessary to guard against vibrations transmitted through the building structure. The most effective barrier to vibration of this kind is the interposition of an air space. An approach to this is made in Absorbo-Phone by the use of finely ground cork. As shown in Fig. 2, strips of natural cork $\frac{3}{4}$ in. thick are fastened lengthwise and crosswise to the floor slab with mastic. Into these spaces specially prepared finely ground cork is distributed. The cork strips are then given a coating of asphaltum and a layer of asphalt felt is spread, the edges of the felt being overlapped and sealed. This gives a non-porous layer of low density, upon which any kind of finished floor can be used without affecting its insulating or sound-deadening properties. The finished floor is separated from the wall structure by a natural cork strip *A*, as shown in Fig. 2.

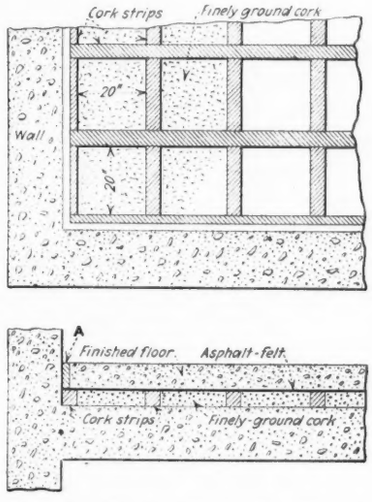


Fig. 2—Typical arrangement of floor insulation

Pipe of Asbestos and Cement

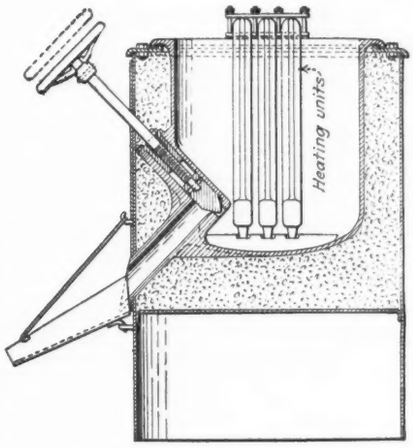
A SEAMLESS pipe made of asbestos and cement, known as Transite pipe, is being introduced in the United States and Canada by the Johns-Manville Corporation, New York City, under patents of the Eternit Pietra Artificial, Societe Anonima, of Genoa, Italy. While new to America, the pipe has been in use for a number of years in Europe, where its durability under various conditions of soil and for a great variety of purposes is said to have been thoroughly established. It will be manufactured in five general classes, one class of light weight designed for flue piping and exhaust stacks, and four pressure classes to carry liquids at working pressures of from 40 to 225 lb. The flue pipe is said not to be affected by ordinary stack temperatures, and the pressure pipe is suitable for delivery of hot or cold water, brine and various process liquids and solutions under pressure.

The pipe material is of dense close grain which is readily cut, tapped or threaded with the same tools and in the same manner as is iron pipe. Its weight is from 50 to 65 per cent less than cast-iron or steel pipe. It will be made in various diameters from 2 to 40 inches.

Electric Melting Pot with Bottom Pouring Spout

AN ELECTRIC metal melting pot with a bottom pouring spout is announced by the General Electric Company, Schenectady, N. Y. The bottom pouring feature is particularly applicable in cases where it is impracticable to ladle and where large quantities of metal are handled. It is designed for melting babbitt, lead, tin, solder, and similar metals except spelter or zinc, at temperatures not exceeding 950 deg. F.

In the new pot the heat is generated right in the metal, affording quick heating and low radiation loss, and the heating units are easily replaceable.

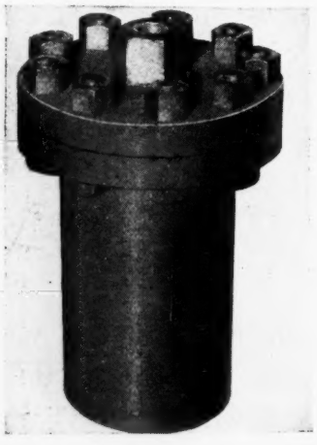


Cross-section of melting pot

The control consists of an automatic control panel and a temperature control instrument. Manual control is not recommended.

Forged Steel Trap for High Pressures and Temperatures

THE forged steel steam trap illustrated, recently announced by the Armstrong Machine Works, Three Rivers, Mich., has been developed for service at high pressures and temperatures. The heavy forged pattern is built for pressures up to 900 lb. and the extra-heavy pattern for pressures up to 1,350 lb. Both types will operate at temperatures up to 750 deg. F.



Forged steel trap

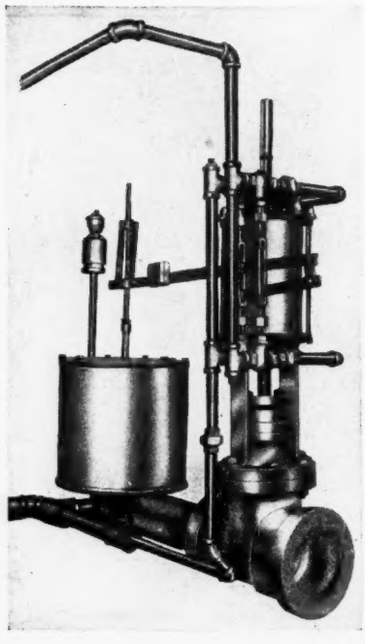
These new traps embody the inverted submerged-bucket principle used on the line of traps made for some years by this company and, in addition, have forged-steel bodies and stainless-steel operating parts. Because of their small size and relatively light weight, no special support is required other than the pipe on which the trap is installed.

Hydraulically Operated Sewer Back-Up Valve

TO OVERCOME the hazards from sewer back-up or overflow in the basement of plants or buildings at the time of heavy storms or maximum flow, the "Sentinel" sewer valve, illustrated, has been developed by the Little Giant Manufacturing Company, 1917 Nicollet Ave., Minneapolis, Minn.

The valve is operated entirely by hydraulic pressure. When in neutral position, it is always open and it remains open until a backup occurs. At the time of a backup the water floods into the float chamber, raising the float. The stem of the float controls a series of four valves. As the float rises, the supply valve at the top is opened and the discharge valve at the top of the hydraulic cylinder is closed. The supply valve at the bottom of the hydraulic cylinder is closed and the discharge valve is opened. This places the hydraulic pressure on the top of the piston, of which the stem of the valve is an integral part. Pressure being downward, this closes the gate of the valve on the sewer line.

When the water recedes, the opposite takes place. The water dropping in the float chamber drops the float. This puts the reverse action on the four valves, putting pressure on the bottom of the cylinder. Pressure now being upward, the gate valve is again opened.



Assembly of "Sentinel" Safety Sewer Valve

The city water supply can be controlled by attaching a rod from the top stem of the cylinder to a quick-opening valve on the cold-water line placed directly above the cylinder. This prevents flooding from the inside in times of storm. In buildings or plants where it is desired to shut off the current on electrically operated apparatus, the same principle may be applied. A rod attached to the stem of the valve can be connected with a make-and-break switch.

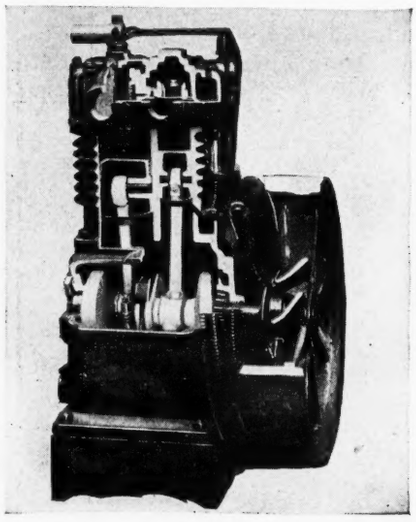
All moving parts of the valve are of bronze, to preclude any possibility of corrosion. Other parts of the valve are made of cast iron and steel. The valve is supplied fully assembled ready for installation and operation.

New Lines of Small Air Compressors

A NEW series of small air compressors, comprising eleven models, in the stationary and portable types, with or without tanks and arranged for motor and gasoline-engine or lineshaft drive, is announced by the Curtis Pneumatic Machinery Company, St. Louis, Mo.

There are three general classes: Single-cylinder, single-stage; two-cylinder, two-stage (duplex); and two-stage. The first two are for intermittent service at pressures not exceeding 150 lb. and are either air- or water-cooled. The two-stage type is for either intermittent or continuous service under pressures from 150 to 200 lb. and is air cooled. All are of vertical construction, and automatic or manual starting and unloading devices are provided as desired. Other important features of design include crankshaft of drop-forged steel, tapered roller main bearings, suction and discharge valves with their seats combined in a nested valve assembly, and disk-type light-weight valves with short travel and small clearances.

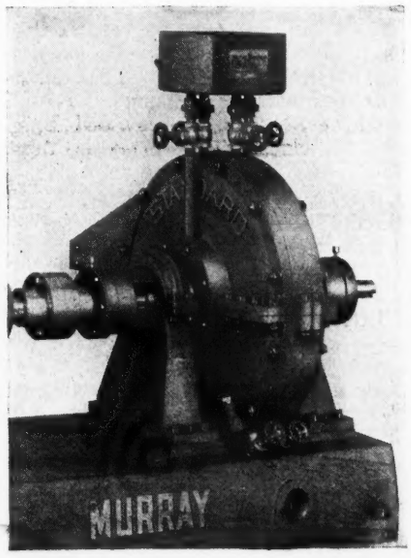
Two-stage compressors have either a single or double coil intercooler system consisting of a copper coil mounted on the high-pressure side. Continuous integral fins on the intercooler increase its radiating surface. The flywheel is equipped with fan blades which increase the cooling by forcing air over the coil. Flat belt pulleys, either tight or loose as desired, are furnished with the compressors.



Cut-away view of two-stage compressor

Absorption Dynamometer

An absorption dynamometer for use in testing steam turbines, steam engines, and the different types of internal-combustion engines in capacities up to 2,000 hp., is being built by



Dynamometer for capacities up to 2,000 hp.

the Murray Iron Works Company, Burlington, Iowa.

The machine comprises from one to ten disks revolving in compartments formed of series of diaphragms. Owing to the rotation the water, when admitted from the tank at the top of the brake, in entering the casing is thrown to the circumference by centrifugal force and there forms a ring at all times.

As the discharge valves are closed off or the inlet valve opened, increasing the braking water surface against the disks, the load is increased or vice versa.

The casing is cylindrical and supported on roller bearings so as to permit rocking and recording the torque on a scale beam.

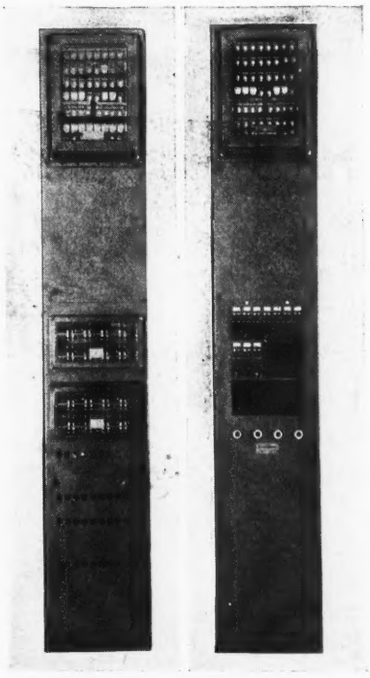
The main bearings of the dynamometer are deep-groove ball bearings for the smaller sizes and self-aligning turbine bearings with forced lubrication for the larger sizes. The bearing supports are so arranged that all the losses are recorded as load on the scale beam, thus eliminating all corrections.

The manufacturer claims for these dynamometers unusual range of absorption and unusual sensitiveness, it being possible to record accurately loads as low as 3 per cent of the maximum, and there have been instances where engines have been run for a period of several days without load changes exceeding $\frac{1}{10}$ per cent of the maximum.

Simplified Synchronous Visual Supervisory Control

AN IMPROVED and simplified synchronous visual supervisory control equipment, designed to combine simplicity of design with high-speed performance is announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

The system provides for any number of remote metering and synchronizing indications as well as any number of remote control operations and



Supervisory control panels

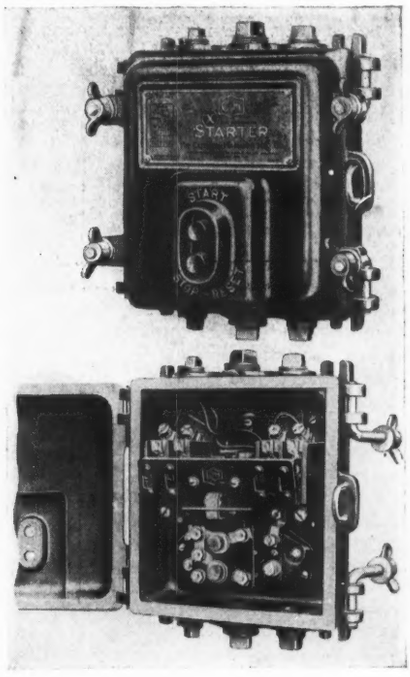
supervision indications—all over the same four line wires. The improved equipment is an all-relay system and any number of apparatus units in systems of any size may be placed under the control of a single dispatcher. The apparatus is normally at rest and is started either by the dispatcher or when an automatic operation takes place in the substation being controlled.

The control is designed to obviate the possibility of a false operation due to any disturbance on the supervisory line wires such as might be caused by lightning or by induction and surges from near-by high-tension line. The equipment is mounted on steel panels giving a compact and readily accessible assembly.

Dust-Tight Enclosures for Motor Starters

THE development of dust-tight inclosing cases for their across-the-line automatic starters, is announced by Cutler-Hammer, Inc., 190 Twelfth St., Milwaukee, Wis. For motors up to 5 hp. the case is of cast iron and for larger sizes it is made of heavy welded boiler plate. A soft rubber gasket is used between the cover and case. Eyebolts with wing nuts at the sides, hold the cover tight. In addition to being dust-tight, the small cast-iron inclosure is also weatherproof. It has the start, stop and reset buttons mounted directly in the cover. The larger sizes have the reset button only in the cover, and a separate dust-tight push-button station provides remote control for the starters.

The new dust-tight equipment will not replace the standard dustproof



Dust-tight inclosing case closed and open

inclosures made by this company, but is to be offered as an option for installation in pulverizing plants, mines and other industries where the dust in the air may interfere with the operation of the starter.

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

FLEXIBLE COUPLING FOR PUMP.—*Is a flexible coupling necessary between a centrifugal pump and its motor if both are bolted to a single rigid cast-iron base?* E. S. M.

A flexible coupling is always advisable and, for many such pump installations, is absolutely necessary. Even though initial alignment of all the bearings is assured by the one-piece rigid base, there is always danger that there is enough dynamic unbalance in the shaft to cause severe vibrations. By dividing the shaft, through using a flexible coupling, into two shorter sections, whipping will not occur at a speed that for the long shaft would be a critical speed.

INCREASED TURBINE STEAM CONSUMPTION.—*We find that the steam consumption of our 1,000-kw. turbine is much higher than heretofore. The condenser vacuum is the same and the boiler pressure remains unchanged.* M. M.

If you are using raw feed water, it is possible that the blading is in bad shape, or the boiler may be priming enough to carry water over to the turbine. This may have eroded the blades, or a slug of water may have broken out all or a part of the blades on one wheel.

STEAM PRESSURE AT END OF EXPANSION.—*One of the questions asked by a New York Board was, "what is the pressure at the end of expansion if the cutoff is at one-third stroke, clearance 5 per cent and the steam pressure 100 lb. gage?" How is this found?* G. W.

When steam expands, the pressure $\times$ volume is always a constant; in other words, the volume at cutoff $\times$ pressure = volume at end of stroke $\times$ pressure at end stroke. The volume at cutoff is equal to $\frac{1}{3}$, or 0.33 of the stroke volume. The clearance is 5 per cent of the total cylinder volume, which is made up of the stroke volume plus clearance volume. Call the stroke volume S, and the clearance volume C, the $S + C = V$, where V is the total volume. As $C = 5$ per cent or $0.05V$, $S + 0.05V = V$, or $S = V - 0.05V$. This makes $S = .95V$. If cutoff is at $\frac{1}{3}$, or 0.33 of the stroke, then the cutoff volume is $\frac{1}{3} \times 0.95V + .05V = .321V$.

The product of initial pressure and cutoff volume is then $0.321V \times (100 + 15)$; absolute pressure and not gage pressure is used in this expression. As already stated, the volume at the end of expansion $\times$ the pressure is equal to cutoff volume $\times$ initial pressure. This can then be set down as $0.321V (100 + 15) = VP$, when P is the pressure at the end of expansion. Solving, we find that P is equal to 37 lb. absolute, or 22 lb. per square inch gage.

While this is the answer obviously required by the examiner's question, it is well to remember that the exhaust valve opens before the end of the stroke, whereupon the pressure drops sharply, so that at the actual completion of the stroke the pressure within the cylinder is practically that existing in the exhaust line, atmospheric, or 0 gage, in case of a non-condensing engine.

HEATING SURFACE OF BOILER.—*How does one figure the heating surface of a horizontal tubular boiler?* E. H.

The total heating surface is usually considered as being made up of $\frac{3}{4}$ shell area + $\frac{3}{8}$ head areas—the area of the tube opening + the surface area of the tubes.

For example, a boiler 72 in. dia. $\times$ 18 ft. long has 84 four-inch tubes. The area of the shell surface is $3.1416 \times \frac{72}{12} \times 18 = 339$ sq.ft. The area of the tube head is $2 \times 0.7854 \times 6^2 = 56.5$ sq.ft. The area of one tube opening is $0.7854 \times \left(\frac{4}{12}\right)^2 = 0.0871$ sq.ft. The two ends of the 84 tubes will have an area of $2 \times 84 \times 0.0871 = 14.6$ ft. The net area of the two heads is then $\frac{3}{8} \times 56.5 - 14.6 = 23.1$ sq.ft.

The area of the tube surface $= 84 \times 3.1416 \times \frac{4}{12} \times 18 = 1,579$ sq.ft.

The total heating surface is equal to $\frac{3}{4} \times 339 + 23.1 + 1,579 = 1,828$ sq.ft.

TRAPPING CONDENSATE TO BOILERS.—*In our factory steam is fed to rolls at 125 lb., this being the boiler pressure. The condensate flows to a small tank connected to an open heater. The temperature in the heater cannot be above 212 deg. F., as it is vented; why cannot the returns be trapped back to the boiler at the temperature corresponding to the 125-lb. gage pressure? What would be the savings?* C. E.

There is no reason why the drips should be led to the open heater. It is possible to use a trap, or traps, to return the condensate to the boiler.

A second method that is automatic, is the Holly loop. The drips can be led to a receiver and then returned to the boiler through the Holly loop.

At 125 lb. gage each pound of condensate contains 324.6 heat units. If this condensate is passed to an open receiver, some of the water will evaporate until the temperature of the remainder reaches 212 deg. F., at which point each pound of water contains 180 heat units. There is then a loss of 324 — 180 = 144 B.t.u. per pound of condensate.

If the boiler is fed water at 212 deg. F., to form steam at 125 lb. gage, a total of 1,192 — 180 = 1,012 B.t.u. must be added per pound. If fed water at 324 deg. F., only 868 B.t.u. need be added. The saving is, then, $\frac{1,012 - 865}{1,012} = 14$ per cent in coal required. There is a loss of 14+ per cent in feed water by putting it through the open heater.

CAPACITY OF AMMONIA COMPRESSOR.—*In the plant where I work we have a 20-ton horizontal, double-acting, Linde ammonia compressor running at 70 r.p.m. The size of the cylinders is 8x19 in. and the speed is 77 r.p.m. Is this speed fast enough to get the full capacity out of the machines? Our evaporating pressure is about 15 lb. gage and the brine from the brine cooler is about 15 deg. F.* G. C.

To perform a duty of 20 tons of refrigeration, heat must be abstracted at the rate of $200 \times 20 = 4,000$ B.t.u. per min. Enough ammonia must be handled by the compressor to absorb this heat.

You do not give the head pressure, but I will assume that the liquid ammonia in the receiver is at a temperature of 70 deg. F., and under the corresponding saturation pressure of 114 lb. gage. Under these conditions a pound of liquid ammonia contains 120.5 B.t.u., measured from —40 deg. F. After it evaporates in the coils at 15 lb. gage, the pound of vapor contains 611.4 B.t.u.; 611.4 — 120.5 = 491 B.t.u. has been absorbed from the coils. To absorb 4,000 B.t.u., obviously one must circulate $4,000 \div 491 = 8.15$ lb. per min. At 15 lb. gage one pound ammonia vapor occupies 9.33 cu.ft., so that the 8.15 lb. will occupy $8.15 \times 9.33 = 76$ cu.ft. This is the volume of gas the compressor must pump per minute.

Assuming a volumetric efficiency of 85 per cent, the piston displacement per minute must be $76 \div .85 = 89.4$ cu.ft. The piston placement per revolution of a double-acting compressor is $2 \times 0.7854D^2 \times S$, when D is the diameter and S the piston stroke. For the 8x19-in. machine the displacement becomes $2 \times 0.7854 \times \frac{8 \times 8 \times 19}{12 \times 12 \times 12} = 1.1$ cu.ft.

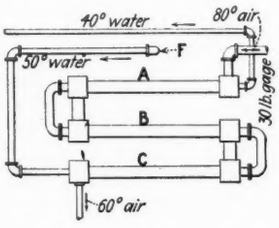
To handle 89.4 cu.ft. the r.p.m. must be at least 82, and to provide for piston leakage, lower volumetric efficiency and pressure drop in the suction line and valves, which increase the volume per pound of gas, the minimum to be used would be 90 r.p.m. The present speed of the machines will not give the capacity you state.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION



IN our plant air at 30 lb. gage and about 80 deg. F. is put through a water cooler, consisting of the double-pipe coils *A*, *B* and *C*, and then goes to a dehumidifier. The air goes into the cooler at 80 deg. and comes out at 60 deg.; the water goes in at 50 deg. and discharges at 40 deg. How can this be?

R. B. C.

IT SEEMS reasonable to believe that there is a leak that allows considerable air to escape into the cooling water. The expansion of the air would cause enough refrigeration to produce the cooling effect noted in the water.

I would suggest that the flow of water to the double-pipe cooler be cut off and the air leak located.

B. C. WEAVER.

Woodland, Calif.

THE air is under pressure and upon being released into the cooler it will expand and absorb heat from the water.

The relationship is expressed by the equation $pv = rt$, where p is pressure, v is volume, t is temperature and r is a constant.

The volume increases while the pressure decreases, and although the total amount of heat has increased the temperature of the air is lower. The water is lower in temperature because of the heat taken from it by the expansion of the air. ROBERT P. O'BANNON.

Louisville, Ky.

THE data given as to temperatures seem contrary to ordinary experience and paradoxical. They would be if the air had been a liquid, and the thermometers might even be suspected of inaccuracy, but in this case wrongly.

Compressed air in expanding and doing work loses some of its internal heat and produces refrigeration. The mistake is frequently made of hoping to produce refrigeration from the mere expansion of air. There is a slight lowering of temperature, the Joule-Thompson effect, but it is of no practical use in refrigeration. The case under discussion, however, is one of expansion and doing work, the work represented by the moving of the piston of air against the frictional resistance of the long, small-diameter tubes usually making up this kind of apparatus. The water in this case could well be dispensed with unless it be used to limit the drop in temperature of the air.

C. O. SANDSTROM.

Los Angeles, Calif.

THE question does not give the value of the rate of water flow or the rate of air flow through the cooler, and naturally the solution of the problem will have to be qualitative instead of quantitative.

It is evident from the problem as stated that the air actually absorbs some heat from the water, since the water enters at 50 deg. and leaves at 40 deg. In other words, for each pound of water which flows through the cooler, 10 B.t.u. is absorbed by the air from the water.

In order for the air to leave the cooler also at lower temperature than it enters, there must be a drop in pressure from 30 lb. gage, at which it enters, to a lower value at which it leaves. A drop in pressure is accompanied by a drop in temperature and the cycle is the reversed Joule.

J. W. HOGG.

L. Lanerch, Pa.

IT SEEMS that a very strange thing is happening in this cooler, through some peculiarity of construction or through some misunderstanding in the performance of the cooler or in the flow of the liquid and the gas.

In a cooler of this type there is a definite relation between the mean temperature difference and the initial and final temperatures of the fluids exchanging heats. It does not seem possible that the cooling water can discharge at a lower temperature than its initial temperature. The air giving up heat, necessarily transfers heat to the heat-receiving water, thereby heating the water. In other words, both substances change temperature by countercurrent flow, the final temperature of one substance tending to become equal to the initial temperature of the other.

This shows that the question as given is against all principles of heat transfer, unless some unknown condition exists, not described in the question.

FRED W. PAFFEN.

Drummondville, Canada.

ONE'S first reaction to this question is a "Ha! The Joule Thompson Effect." But a setting down of the temperatures recorded proves that this is not the explanation. The real discrepancy can be traced either to the location of the air thermometer so far from the cooler that the air has absorbed heat from the air, or to an uncovered thermometer stem which might raise the reading 10 or more degrees.

If there was wiredrawing of the air through the cooler, with the consequent work done on the air ahead of it, a cooling effect would occur. This might be enough to cause the water to drop in temperature as low as 40 deg., but as the air is now below or equal to the water in temperature, there would be nothing to bring its temperature up to 60 deg., which is 10 deg. above the water inlet temperature. The air might reach 50 deg., but would never exceed this value.

Like the Cardiff statue the problem looks like the real thing but the engineer should relocate his thermometer—for he has not discovered a new physical phenomenon. JOHN WILSON

Camden, N. J.

Other answers were received from C. A. Brant, Philadelphia, Pa.; John Scott, Brooklyn, N. Y.; J. Cassiday, Newark, N. J.; which space limitations prevent publishing.

A Question For Our Readers

USING a treated boiler-feed water, what should be the per cent yearly increase in steam consumption of a 1,000-kw. turbine, the boiler pressure being 300 lb. with 150 deg. superheat?

C. M.

Suitable answers from readers will be paid for and published in the July 2 issue.

Time Out for Progress

The Engineer As Well As the Business Man Must Read to Keep Up With the Procession

THE utterly incomprehensible thing about so many so-called practical business men is that they insist on being so utterly unpractical! They persist in learning everything for themselves by the costly and time-consuming process of experience, whereas much that they learn has already been learned for them and made quickly available.

The story has been told before, but is so to the point that it will bear repeating, of a New York business man who called in a well-known business counselor to advise with him in connection with a certain perplexing problem in his business. Three days later this business man received from the "expert" a lengthy report outlining how another company (name not mentioned) had worked out a similar problem. Accompanying the report was a bill for a sum in four figures.

The recommendation was just what was needed, and a check was mailed promptly and cheerfully.

It was fortunate for this executive's peace of mind that in clearing off his desk at the end of that week, he threw away without examining it a certain technical journal of his industry which had lain there for two weeks and which he had been "too busy" to read; for in that journal was the complete story upon which the expert's report was based. The only difference was that it was written more briefly and simply, and the company name was given so that he would have been in a position to get further details if he had wanted to follow it down!

Life—and particularly a man's business life—is far too short to learn everything from personal experience. The first ten or fifteen years, those terribly busy years during which so many of us are "too busy to read," are the great progress years; but no man, other than an absolute genius, can hope to crowd into his own personal experience all he needs to get out of these precious ten or fifteen years. Nor need he, for the experience of other men—most of them better men than he is, as yet—is available to him in books and periodicals.

How many men look upon books as merely printed pages between covers!

Actually, books are reservoirs of human experience. And their cousins, the periodicals, are the streams of experience, flowing steadily along with the stream of life. To dip into either is helpful and stimulating; to drink from both regularly is to keep one's mind fresh and vigorous, and to let other men's viewpoints and experiences flow in to enrich one's own life and develop its potentialities.

It is all rot for any man to say that he has no time to read. He is merely admitting that he is not big enough to boss himself around, or that he is so egotistical that he thinks he knows it all already, which is worse. Dr. Arthur E. Bostwick, head of the St. Louis Public Library, put it squarely when he said, "He who complains that he has no time to read is one who does not fundamentally care for making contact with the minds of others. We always find time to eat. When we have realized that mental food is equally necessary to the maintenance of our intellectual life, we shall take as much time as is necessary for reading also."

"Books are reservoirs of human experience. Their cousins, the periodicals, are the streams of experience, flowing steadily along with the stream of life," writes Robert R. Updegraff in this abstract of his article, which was published in the May issue of the *Magazine of Business.*

Not that the less keen man does not promise himself to keep abreast with his fellows. He firmly intends to keep posted on what other men have found out and are finding out. He buys books and he subscribes to the journals of his profession, but he is "too busy" to carry through. He lets the physical presence of lesser men consume the time that he might be spending with minds of his own caliber—or higher caliber. He lets himself get so tired during the day that he doesn't feel like reading when night comes, and he doesn't read during the day because he is so busy making the wheels of the machine spin around that he has no time to look up from his work to see if the machine is going anywhere, or if so in what direction. He cannot bring himself to take a little time for progress, so he makes little progress.

The great need of any business man today is to keep abreast of progress, and regardless of the industry or field of thought or action, so well is the news of business now covered that the printing press keeps abreast of progress all the time. It used to be that the great leaders of finance and commerce and industry were months ahead of the rank and file in their knowledge and plans. But it is difficult now for more than one or two persons to know a thing without that knowledge being available to their competitors and to the business world at large. The strange thing about it is, that so many of us are so engrossed in groping along a narrow dark path of our choosing that we cannot take the time to raise the curtains of our own ignorance and let in the light of knowledge and experience along our way. We plow under a mass of papers and details, like moles.

Some men grow lax in reading the journals in their fields because "nothing happens" if they miss a few issues—they are not instantly forced into bankruptcy. But something is happening every day to such men; they are being left behind by the men who force themselves to take time out for progress. They will never realize it until it is too late.

Where to get the reading time seems to be the big problem. Inasmuch as reading means progress, it would seem as though the business man could afford to make it one of his major business concerns, and that as such he might well plan to devote part of his business day to it rather than depend on his evening hours, when he ought to be free from business and its problems.

I know all the objections. We all do. We have all made them. But I know, also, the president of one of the fastest growing mercantile businesses in this country, with more than 500 branches and with more pressing problems and more detail than confronts almost any man of my acquaintance, and he takes part of nearly every day for reading.

The man who expects every hour of his reading to develop definite ideas that come from outside of himself will possibly be disappointed with what he gets from a given number of hours spent in reading, but he can never be disappointed in the stimulus to progress that will come from regular exposure to the currents of life that flow through our periodicals, and the experiences and ideas and viewpoints that the world's thinkers have set down in books.

Admittedly, one must make the time to read. This can be done as part of a more fundamental plan of working, involving taking the subconscious mind into one's business. It has been suggested that whereas some men cannot very well actually leave their offices at three o'clock every afternoon, they can "retire" for the day in the sense that from then on to closing time they can refrain from doing anything in the nature of conscious application to the problems or details of their jobs. (Of course, this applies only to major executives who are their own bosses.) They can, figuratively speaking, put their feet up on their desks and let their minds play, and still be available in emergencies and for the moral influence on the organization discipline.

Part of this time can well be devoted to leisurely reading. An hour a day for

reading, out of the two-hour margin allowed by the six-hour day for progress, will permit a man remarkable contacts with the men and movements in his industry or profession, keep him "headed into the wind" in his own thinking, and still allow him a margin of time for more general reading to suit his taste, whether his taste runs to detective stories or classics.

Woodrow Wilson found the reading of detective stories helpful when he was President, for while following down the clue in a detective story with his conscious mind, he found that his subconscious mind took over the enormous and vexing problems of the Great War and of the President's office. Many of his best ideas and decisions were those that came to him while he was buried in such a book, rather than when he was sitting at his desk in the White House Office Building.

One of the most successful manufacturers I know, and an old hard-shell of whom it would never be suspected, confessed to me recently that for years he has made it a rule to devote one hour each day of his office time to reading. He told me that when he first made the bargain with himself to do this he found it almost impossible to accommodate the affairs of his day to the plan, but that by perseverance it was managed, and the very licking of that problem gave him a self-respect and a sense of control over his job that moved him forward several points in his effectiveness. Even then, it took some weeks before he could relax while reading at the office.

At first, he said, he went at his reading tensely, as though every minute of it should yield some new idea of principle; but presently he felt more at home with himself in his reading hour and began to let go and rest while he read. Then he discovered that while reading, many ideas, often not in any way related to what he is reading, would come popping into his head. He began presently to recognize these ideas as contributions from his subconscious mind—contributions that made for his personal progress.

I am convinced that any man who will set aside one hour of each day regularly for reading which puts him in contact with the thoughts and experiences of his fellow men, will more than make up for the hour he gives to it by enlisting in his work the ideas and experience of a score or a hundred capable men who will take hold of his job with him and help him to travel forward at a rate that will astonish him. Nor does it make so much difference what he reads; it is the stimulus of keen minds and fresh ideas, and the opportunity the subconscious mind gets to work on the problems of one's job while the conscious mind is vacationing in a book or magazine, that count in progress. And never in the world's history has it been so important to take time out for progress as it is in this highly competitive age which demands results from every bit of energy expended.

Studies in the Classification of Coal

By A. A. POTTER

Dean of the Schools of Engineering and Director of Engineering Experiment Station, Purdue University

BULLETIN No. 180 of the University of Illinois Engineering Experiment Station at Urbana, records the results of experiments and studies that have been carried on for many years under the direction of Prof. S. W. Parr. The details of particular interest include:

The first suggestion in the United States of a basis for classification of fuel is found in Senate Document 386, printed in 1844. This report gives data from evaporative tests on 43 samples of fuel. The coals tested are arranged in the order of the ratios of fixed carbon to the volatile matter, and this ratio is shown to have a constant relation to the evaporative power of the fuels tested.

The fundamental factors in coal classification are oxygen content and volatile matter, which are vitally related to the type of coal.

To use calorific values for purposes of classification these must be made to relate definitely to the pure coal substance designated as "Unit Coal." This involves not only the elimination of all mineral and extraneous matter, but the correcting of the values ordinarily obtained in analysis, especially for ash, in such a manner as to make it possible to arrive at the percentage of actual combustible in the original material. The formula for "Unit Coal" is given as:

$$Unit\ Coal = 1.00 - \left(1.08\ A + \frac{22}{40}S\right)$$

(A is the ash as weighed and S is the sulphur).

The "Unit B.t.u." is represented by the indicated heat value as derived by the calorimeter divided by the unit coal factor, or:

$$Unit\ B.t.u. = \frac{Indicated\ B.t.u. - 5{,}000S}{1.00 - \left(1.08\ A + \frac{22}{40}S\right)}$$

(The expression $5{,}000S$ is used as indicating the resultant of burning of sulphur to SO_2 and the iron in coal to Fe_2O_3).

The accuracy of the "Unit B.t.u." formula was demonstrated by results from samples that have been subjected to the "sink" and "float" process.

Since the volatile matter as determined in the ordinary method of proximate analysis includes as a non-coal constituent the water of hydration of the shaly constituents of ash, and essentially one-half of the total sulphur, the factors may enter into the calculations in deriving the "unit volatile matter" of coal, for which the following formula is given:

$$Unit\ Volatile = \frac{volatile\ as\ determined - (0.08 + 0.45)}{1 - (1.08\ A + 0.55\ S)}$$

The limiting boundaries of the several types of natural solid fuels are indicated by areas on a chart the co-ordinates of which are B.t.u. (unit coal) and per cent volatile matter (unit volatile).

The classification recommended, known as the Parr System of Coal Classification, includes the following types: Type 1, anthracite; Type 2, semi-anthracite; Type 3, bituminous A (low volatile or Pocahontas); Type 4, bituminous B (Eastern); Type 5, bituminous C (Mid-Continental); Type 6, bituminous D (sub-bituminous or black lignite); Type 7, lignite; Type 8, peat, and Type 9, cannels.

Analytical data are given for samples of solid fuels under the foregoing classification, including type, location, seam, moisture, volatile matter, fixed carbon, ash, sulphur, B.t.u., calories, unit B.t.u., and unit volatile. Tables are given for coal in the United States, North America (outside of U. S. A.), South America, Europe, Asia, Africa and Australia. The Parr Classification for coals outside of the United States, is included.

A bibliography is given at the end of the bulletin, which includes 111 references to the development of methods of coal classification.

The publications of the United States Bureau of Mines of the Department of Commerce contain the most authoritative information in the United States about fuels. The List of Publications of the Bureau of Mines (1910-1928) includes 292 bulletins and 437 technical papers. Many of these are of interest to the power industry and cover such subjects as the deterioration of coal when stored, methods of analyzing coal, fusability ash in coal, preparation and use of lignite, and a number of bulletins dealing with the combustion of fuel and furnace design.

[*The article in the July issue will deal with "Engineering Research in Germany."*—EDITOR.]

Electric power will play a vital part in the construction of the gigantic new tunnel which will be built for the purpose of adding to New York City's water supply. This tunnel will be 20.2 miles long, 17 ft. in diameter and will be at a depth of about 500 ft. below sea level.

Compressed air for drills and shovels will be furnished by 400-hp. synchronous, motor-driven compressors. As the muck is removed it will be hauled through the tunnels to hoists by storage-battery mine locomotives, of which there will be 62. Sixteen electric mine hoists will carry it to the surface.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Survey Emphasizes Advances in Power Generation

THE great advance made in recent years by central stations generating electric power, in the more economical consumption of fuel per kilowatt-hour generated, is emphasized in the survey of the National Bureau of Economic Research conducted for the Committee on Recent Economic Changes of the President's Unemployment Conference. The survey is to be published shortly with the committee's report on the National Bureau's findings.

Data on central station efficiencies were gathered by L. P. Alford, engineering authority and vice-president of the American Engineering Council, who points out in the survey under "Technical Changes in Industry," that central stations had succeeded in 1927 in reducing the consumption of fuel to 57 per cent of what it was in 1919 per unit of electrical energy generated. During that same period the output of energy had more than doubled, the figures in millions of kilowatt-hours being as follows: 1919, 24,315; 1920, 27,405; 1921, 26,005; 1922, 30,453; 1923, 36,327; 1924, 39,044; 1925, 43,514; 1926, 47,602; 1927, 50,330.

The writer points out that the advances in the design, construction and operation of large steam central stations in the last decade have been principally along three lines: (1) Larger generating units using steam turbines exclusively as prime movers, and larger boilers; (2) higher steam pressures and superheat temperatures; and (3) greater use of waste-heat recovery apparatus.

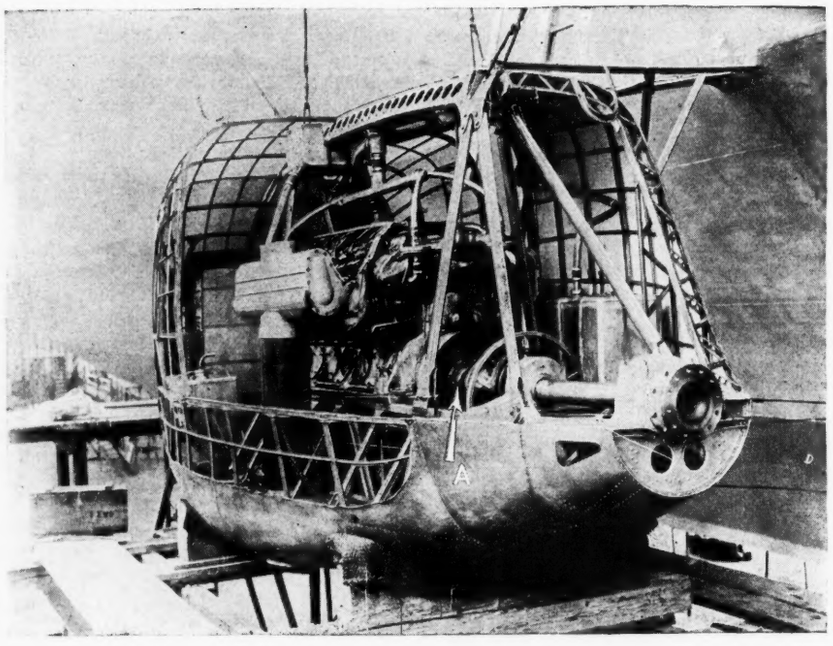
"To these," he writes, "might be added improvements in all auxiliary machinery, to the advantage of the over-all efficiency of operation. A rough idea of the advance in efficiency may be had from the fact that for one station generating from 20,000 to 100,000 kw., the present rate of coal consumption is about 2 lb. per kw.-hr. as against 3.5 lb. per kw.-hr. ten years ago. Heat economies have also been introduced all the way from the furnaces to the last expansion stage of the turbine.

"Higher efficiencies than now obtained by the best, about 13,000 B.t.u. per kw.-hr., or better than 26 per cent, are expected and can be produced; but not a great deal higher for the best all-round results. The trend at present is rather to raise the general average power generation all over the country, than to construct occasional units of exceptional efficiency, leaving the majority of power plants in their present condition.

"Today, central-station pressures are to be found in three ranges for modern installations: (1) A range around 400 lb. per sq.in.; (2) a range from 550 to 750 lb.; (3) a range from 1,000 to 1,400 lb. The greatest activity at present is in the first and third ranges, the intermediate one being proportionately neglected. The choice between these two, the basis of selection, is partly a matter of load, but more a matter of coal price. For a cheap coal with a small average load, the 400-lb. range is preferred; with a higher-priced coal and a high average load the 1,000-lb. range is preferred; and usually we find both in the same station. Thus in modern existing stations, with units already in use operating at 400 lb. or less, 1,000-lb. boilers and high-pressure turbines can be added.

"Temperatures are now limited to about 750 deg. because as yet the metallurgists have not been able to provide a steel at a usable price that is perfectly reliable for higher temperatures. The tendency, however, is upward and 850 deg. is already in use to a limited extent.

"There is also a tendency toward larger boiler units; some are in operation today that are good for over 400,000 lb. of steam per hour per boiler. Others under erection have a specific capacity of 1,000,000 lb. of steam per boiler per hour. It seems probable that the practice will be soon to provide each turbine with its own boiler, no matter how large the turbine."



ONE of the Graf Zeppelin motors which failed on a recent trip the airship was making to America. Crankshaft breakage at point A forced the dirigible to land in France a short time after it had left Germany.

Program of A.S.H.&V.E. Summer Meeting Announced

The 35th semi-annual meeting of the American Society of Heating and Ventilating Engineers will be held June 26-28 amid the unusual scenic beauties of Canada at Bigwin Inn, Lake-of-Bays, Ontario. A splendid array of technical papers is enhanced by the entertainment program arranged by the Ontario Chapter of the Society. Golf, swimming, fishing and other outdoor sports will be the chief recreations, while the business sessions will be held in a pavilion at the water's edge.

A greeting by E. B. Sheffield, president of the Ontario Chapter, will open the meeting on Wednesday morning, June 26. Thornton Lewis, president of the A.S.H.&V.E., will respond, and then four technical papers will be presented, as follows: "The Measurement of Air Velocity," by Prof. J. H. Parkin;

"Overall Heating Efficiency of the Research Residence Warm-Air System Analyzed," by Prof. A. P. Kratz and J. F. Quereau; "Air Conditioning System of a Detroit Office Building," by H. L. Walton and L. L. Smith, and "Report of Committee on Code for Testing and Rating Unit Heaters," by D. E. French.

The report of the Committee on Interpretation of the Code for Rating Low-Pressure Heating Boilers will be given on Thursday morning by L. A. Harding, chairman, followed by "Determining Dust Quantities in Air," by Prof. F. B. Rowley; "Capacity of Radiator Supply Branches for One and Two-Pipe Systems," by F. C. Houghton, M. E. O'Connell and Carl Gutberlet, and "Pipe Sizes for Hot Water Heating Systems," by Prof. F. E. Giesecke and E. G. Smith.

On Friday papers on "Time Lag as a Factor in Heating Engineering Practice," by James Govan; "Overall Heat Transmission Coefficients as Determined by Test and by Calculation," by F. B. Rowley, A. B. Algren and J. L. Blackshaw, and "Five Suggested Methods of Appraising Insulations," by Paul D. Close, will be presented. The meeting will close with the report of the Advisory Committee on the Heating and Ventilating Exposition.

Two golf tournaments, a lawn bowling contest, a boat trip and dancing every evening will be some of the features of the entertainment program.

Men in the News

CONRAD N. LAUER

has been elected a vice-president of the United Gas Improvement Company and president of the Philadelphia Gas Works Company. A native of Pennsylvania, Mr. Lauer entered the employ of the Link-Belt Company in 1893, where he advanced to the position of plant superintendent. Later he became vice-president of Day & Zimmerman, Inc., and achieved a country-wide reputation as an industrial engineer. He is a member of the Council of the A. S. M. E. and author of the book, "Engineering in American Industry."

Spot * News

PRESIDENT HOOVER *has invited the Governors of all the oil-producing States in the West and Southwest to send representatives to a preliminary oil conservation conference to be held at Colorado Springs, June 10, to consider the possibility of effecting an interstate compact on the conservation of oil.*

* * *

TO SAVE *a flooding mine from destruction, the Worthington Pump & Machinery Corporation assembled at its Holyoke Works a pump weighing 40,000 lb., and shipped it 28 hours after the order was received. The mine, located at Valedon, N. M., was being flooded at the rate of 400 g.p.m. and complete destruction was averted only by the timely arrival of the pump.*

* * *

THE FIRST GATHERING *of engineers and metallurgists to be held in Germany since 1914 will take place in Dusseldorf Sept. 9-12, when the British Institute of Metals holds its German meeting at which nearly every country in Europe will be represented.*

* * *

THE RECENT DECISION *of the United States Supreme Court upholding the validity of the President's pocket veto prevents Senator Norris' Muscle Shoals Bill from becoming a law.*

* * *

THE CONTROL *of the Commonwealth Power Corporation, the Southeastern Power & Light Company, and the Penn-Ohio Edison Company whose combined assets are over a billion dollars, will be vested in a new corporation formed for the purpose and known as the Commonwealth and Southern Corporation.*

* * *

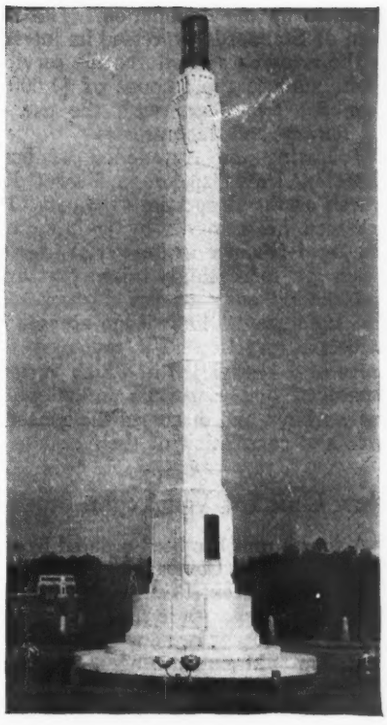
DEDICATION *of the two largest steam-turbine generators in the world at the Hell Gate Station of the United Electric Light & Power Company by Matthew S. Sloan, president of the New York Edison Company and associated companies, took place on May 29. These units, each of 160,000 kw., will bring the capacity of the station up to 605,000 kw., making it the largest steam plant in the country.*

* * *

PLANS *are already being made to celebrate in 1930 the one-hundredth anniversary of the discoveries of Faraday which have made possible the generation and distribution of electric power.*

* * *

LONDON'S KITCHEN *refuse will be used as source of power by Henry Ford to operate the new motor factory he is erecting at Dagenham, England. A large destructor plant coupled with an electric generating station will be constructed to make this possible.*



This granite memorial shaft was completed recently at the Jordan Dam Power plant of the Alabama Power Company. Combining utility with unusual beauty, it provides a powerful aviation beacon light to guide airships that pass in the night.

Engineering Foundation Increases Fund

The Engineering Foundation announced at a dinner meeting held in the Century Club, New York City, May 23, that it had raised $720,000 of its proposed endowment fund of $5,000,000 through the co-operation in research of the Society of Naval Architects and Marine Engineers, the Batelle Memorial Institute and the Bureau of Standards. It was also announced that James H. McGraw, chairman of the board of the McGraw-Hill Publishing Company, had contributed $50,000 toward a fund of $2,000,000 for the Engineering Societies Library. H. Hobart Porter was installed as chairman of the Foundation, and Harvey N. Davis, president of Stevens Institute of Technology, was the guest of honor at the meeting.

The Society of Naval Architects and Marine Engineers proposed to add its research endowment of approximately $100,000 to that of the Foundation in the interest of more effective use, and its offer was accepted. The Batelle Memorial Institute of Columbus, Ohio, offered $50,000 for the Alloys of Iron Research, to be spent at the rate of $10,000 a year, on conditions that were

accepted by the Foundation. The Bureau of Standards expressed its interest in the research and offered the services of its staff to the amount of $1,000 a year for five years with the use of its library and laboratories.

Following the transaction of business Dr. Davis spoke on Recent Research on the Properties of Steam. He prefaced his remarks by pointing out the rapid advance in industrial uses of steam at increasingly high pressures and the difficulty of keeping research and fundamental knowledge abreast of industrial practice. He reviewed the areas of investigation in which various American and European investigators are working, and discussed the concordance and correlation of their results.

New Unit for Waukegan Station

A fourth unit has been ordered by the Public Service Company of Northern Illinois for the extension of its Waukegan generating station. The order, which has been placed with the Allis-Chalmers Manufacturing Company, includes a 65,000-kw. tandem steam-turbine generator with condenser, circulating water and condensate pumps. The new unit will be similar to the 50,000-kw. unit installed in 1927, except that it will be arranged for boiler reheat and will operate at 600 lb. pressure and 725 deg. total steam temperature.

Diversified Program Planned for A.I.E.E. Summer Convention

A large number of high-grade technical papers and many interesting trips will feature the summer convention of the American Institute of Electrical Engineers at the New Ocean House, Swampscott, Mass., June 24-28. The papers will cover many live topics, such as distribution systems, automatic synchronizing, power plants, electrical machinery, outdoor hydrogen-ventilated synchronous condensers, electrical heating elements, loading transformers according to temperature, communication, shielding in electrical measurements, etc. Reviews of the latest electrical developments will be presented in the annual reports of the technical committees.

On Monday, June 24, a conference of officers and section delegates will be held. The business sessions will begin on Tuesday morning with an address of welcome by Governor Allen of Massachusetts, followed by two technical sessions on distribution and power plants, and transportation. A symposium on "Synchronized at the load" and a paper on "Rehabilitation and Rebuilding of Steam Power Plants" will be presented. The afternoon will be devoted to trips and sports, and the convention lecture will be given at 8 p.m. by Dr. Harlow Shapley, director of the Harvard College Observatory.

The technical sessions will continue on Wednesday and on Thursday an all-day trip will be made to Rye Beach, Maine. The final technical session will be held on Friday morning.

Coming Conventions

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Bigwin Inn, Lake of Bays, Ontario, Can., June 26-28. A. V. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Calvin Rice, secretary, 29 West 39th St., New York City.

American Society of Refrigerating Engineers. Summer convention at Penn State College, State College, Pa., June 20-22. Secretary, W. H. Ross, 35 Warren St., New York City.

American Society for Testing Materials. Annual meeting, June 24-28, at Chalfonte-Haddon Hall, Atlantic City, N. J. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Fall meeting at Cleveland, Ohio, Sept. 9-13. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill. Conn. State Association annual meeting, June 14-15, at the Stratfield Hotel, Bridgeport, Conn. New England States Association annual meeting, June 20-21, at Fitchburg, Mass.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting, June 18-20, at Detroit, Mich. Secretary, C. O. Myers, 14 Commercial Nat'l Bank Bldg., Columbus, Ohio.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National District Heating Association. Annual meeting, June 11-14, at the Hotel Statler, Detroit, Mich. Secretary, D. L. Gaskill, Greenville, Ohio.

National Oil and Gas Power Meeting. Under auspices of A.S.M.E. Oil and Gas Power Division and the Pennsylvania State College. June 24-27. State College, Pa. F. G. Hechler, chairman, State College, Pa.

Northwest Electric Light and Power Association. 22nd Annual Convention, June 26-29, 1929, at Seattle, Wash. Registration and information: J. J. Hayes, Westinghouse Electric & Manufacturing Company, Seattle, Wash.

Universal Craftsmen Council of Engineers. Annual meeting in Detroit, Mich., Aug. 6-10, at the Book-Cadillac Hotel. Grand Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

OBITUARY

WILLIAM A. BASSETT, director of the division of municipal and industrial research at the Massachusetts Institute of Technology and an authority on governmental problems, died in the Homberg Infirmary, Cambridge, Mass., May 16. He was fifty-four years old.

Professor Bassett was for ten years consulting engineer for the New York Bureau of Municipal Research, serving from 1912 to 1922 and taking the post after he had been assistant chief editor of the *Engineering Record*. An expert on roads and roadway construction, Professor Bassett was connected with many large enterprises for engineering and research work.

He also served on the Hoover Committee for Simplification of Building Codes and Practices and on the Advisory Board for Highway Research of the National Research Council. He was a member of the American Society of Electrical Engineers, the American Society for Municipal Improvement and other organizations.

G. G. FLEMING, sales manager of W. B. Coleman & Company, Metallurgists-Chemists-Engineers, of Philadelphia, Pa., died of pneumonia, May 16, at his home in Camden, N. J.

PERSONALS

W. F. DURAND, emeritus professor of mechanical engineering at Leland Stanford University, Palo Alto, Calif., has departed for Europe at attend an aërodynamics conference being held in Germany under the sponsorship of the Guggenheim Foundation. Professor Durand is one of the three engineers recently appointed by President Hoover to serve on the Boulder Dam Commission.

JOHN F. PETERS, consulting engineer of the Westinghouse Electric & Manufacturing Company, was awarded the Longstreth Medal at a meeting of the Franklin Institute in Philadelphia on May 15, for his invention of the klydonograph, the only simple device in the world for recording the effect of lightning as it strikes a transmission line.

B. E. MORROW, who is one of the small group eligible to wear the "Edison Pioneers" insignia, has been appointed chief engineer of the Consumers Power Company, of Jackson, Mich.

MILTON W. ELMENDORF has tendered his resignation to the Pfaudler Company to enter the engineering division of the Taylor Instrument Company's Rochester plant.

E. B. CURDTS, for the last eight years engaged in the design and layout of power-plant installation for the Virginia Electric & Power Company, has joined

the Narragansett Electric Company, of Providence, R. I., as an engineer in the production division.

JOHN E. SLATER has resigned as secretary and treasurer of the American Brown Boveri Corporation, to become associated with Cloverdale & Colpitts, consulting engineers.

J. A. CLAUSS, for the last three years chief engineer of the Trumbell Steel Company, which is now the Warren Works of the Republic Iron & Steel Company, has resigned to accept the position of chief engineer of the Great Lakes Steel Corporation, Detroit, Mich.

W. M. SHEPARD, since 1924 vice-president of the California Oregon Power Company, has resigned to accept a position with the American & Foreign Power Company in Buenos Aires, Argentina.

BUSINESS NOTES

McCLAVE-BROOKS COMPANY, of Scranton, Pa., has moved its Southeastern district office from Atlanta, Ga., to Greenville, S. C.

FOOTE BROS. GEAR & MACHINE COMPANY, of Chicago, has moved its general offices to more modern and commodious quarters at 111 N. Canal Street.

FORSTALL, ROBISON & LUQUEER, consulting engineers, have moved their offices to the Woolworth Building in New York City.

THE LEAVITT MACHINE COMPANY, Orange, Mass., announces the appointment of the Power Plant Equipment Company, 5473 Delmar Blvd., St. Louis, Mo., and H. M. Gassman, 513 N. 21st St., Birmingham, Ala., as agents in the respective territories.

THE ALEMITE MANUFACTURING CORPORATION, of Chicago, has purchased the line of industrial lubricating equipment bearing the DOT name and formerly manufactured by the Carr Fastener Company, Cambridge, Mass.

THE IDEAL COMMUTATOR DRESSER COMPANY, Syracuse, Ill., has moved its Eastern office and warehouse to 18 Warren St., New York City. R. W. Becker and F. J. Dreyfuss will have charge of the new establishment.

THE AMERICAN ARBITRATION ASSOCIATION announces the opening of its new Arbitration Tribunals at 521 Fifth Ave., New York City, and the establishment of tribunal facilities in 1,600 U. S. cities and towns. These tribunals are available to the public and business generally.

THE BROWN INSTRUMENT COMPANY has moved its Pittsburgh office to larger quarters at 1522 Oliver Building to care for increased business.

TRADE CATALOGS

LINESTARTERS—Leaflet 20403 is a new publication of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., describing and illustrating class 11-210 reversing linestarters for squirrel-cage induction motors.

CRANES—The Tiger crane, manufactured by the Whiting Corporation, of Harvey, Ill., is covered in a 24-page Bulletin No. 188, which is illustrated and bound in color.

TRANSFORMERS — Wagner Electric Corporation, St. Louis, Mo., has issued a 12-page pamphlet, No. 164, on transformer performance. This contains a discussion of losses occurring in distribution and power transformers, and methods of making tests from test data.

TRANSMISSION—Booklet 102, dealing with the cost of power transmission has just been published by the Diamond Chain & Manufacturing Company, Indianapolis, Ind. This illustrated booklet has twenty pages.

SMOKE DENSITY METER — Frank Sawford, Vancouver, Canada, gives a complete description of his smoke density meter in a well-illustrated, 10-page bulletin, No. 442. Valuable operating data are included in the booklet.

LIGHTING—The Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., announces a new publication, No. C1757-B, on Resonant Control for Street Lights. This 12-page booklet tells in an interesting way the Westinghouse method, recently perfected, of control for street lighting systems.

WELDING — Smithwelded pressure vessels for operation at high pressures and temperatures are illustrated and described in Bulletin No. 506, recently issued by the A. O. Smith Corporation, Milwaukee, Wis.

STEAM SPECIALTIES—An entirely new 16-page catalog R, dealing authoritatively with the steam specialties it covers, among which are gage cocks, water gages and safety water columns for working pressures up to 1,500 lb., has been published by the Reliance Gauge Column Company, 5902 Carnegie Ave., Cleveland, Ohio.

JAW CRUSHERS—The Smith Engineering Works, Capitol Drive, Milwaukee, Wis., has just issued Bulletin No. 246B which describes various types of Telsmith jaw crushers. The booklet has 10 pages and is well illustrated.

FLOAT SWITCHES — Bulletin GEA-1114 describes and illustrates solenoid-operated valves for the remote control of liquids and gases under pressure, and Bulletin GEA-67A covers float switches for use with automatic pumping equipment. Both are issued by the General Electric Company, Schenectady, N. Y.

COATING TANKS—Electrically heated large asphaltum coating tanks are described in a 10-page illustrated bulletin, No. 160, issued by H. O. Swoboda, Inc., 3400 Forbes St., Pittsburgh, Pa.

GAS BURNERS—"The Challenge to Waste" is the title of a new catalog published by the Lee B. Mettler Company, 406 S. Main St., Los Angeles, Calif. It is an 18-page illustrated bulletin describing combustion gas burners and the No. 42 combination gas and oil burning unit.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35 @ $2.40
Kanawha	Columbus	1.25 @ 1.45
Smokeless	Cincinnati	1.75 @ 2.00
Smokeless	Chicago	1.75 @ 2.25
S. E. Kentucky	Chicago	1.35 @ 1.60
Steam	Pittsburgh	1.55 @ 1.65
Gas Slack	Pittsburgh	1.00 @ 1.15
Big Seam	Birmingham	1.25 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75
Barley	New York	1.50

FUEL OIL

New York—May 31, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 5.25c. per gal.; 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—May 29, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.3708 per bbl. or 42 gal.; 26@28 deg., $1.4208 per bbl.; 28@30 deg., $1.4708 per bbl.; 30@32 deg., $1.5208 per bbl.; 32@36 deg., gas oil, 4.151c per gal.; 38@40 deg., distillate, 5.23c

Pittsburgh—May 20, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia—May 29, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.627@$1.677 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—May 27, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—May 24, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 60c. per bbl.; 26@30 deg., 72.5 per bbl.; 30@32 deg., 95c per bbl.

Boston—May 27, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.35c. per gal.; 28@32 deg., 5.5c. per gal.

Dallas—May 25 f.o.b. local refinery, 26@30 deg., 1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Conn., Bristol—New Departure Mfg. Co., 269 North Main St., is having plans prepared for the construction of a boiler house including two 600 hp. boilers, 500 hp. turbine, etc. at general forge plant. Lockwood, Greene & Co., 100 East 42nd St., New York, are engineers.

Ill., Chicago—J. T. Wheeler & Associates, 134 North La Salle St., is having plans prepared for the construction of a 16 story apartment building including refrigeration system, etc. on La Salle St. and Maple Ave. Estimated cost $1,500,000. L. Guenzel, 879 North State St., is architect.

Ill., East Moline—Peoples Power Co., R. B. MacDonald, Pres. and Gen. Mgr., Service Bldg., Moline, plans the construction of a 50 x 85 ft. power sub-station here. Estimated cost $300,000.

Ind., Michigan City—Northern Indiana Public Service Co., will soon award contract for the construction of a generating station. Holabird & Root, 333 North Michigan Ave., Chicago, Ill., are architects.

La., New Orleans—Favrot & Livandais, Hibernia Bank Bldg., Archts., will receive bids until June 11 for a 9 story medical building including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. on Tulave Ave. for Tulave University.

Mo., St. Louis—Builders Investment Co., E. W. Banister, Pres., Paul Brown Bldg., will soon award contract for a 35 story office building at 12th Blvd., Olive to Pine Sts. Manske & Bartling, 4526 Olive St., are architects. W. J. Knight & Co., Wainwright Bldg., are engineers.

Neb., Atkinson—Western States Utilities Co., H. Hord, Pres., Central City, awarded contract for the construction of an electric power and ice plant to Betts-Blumer Engineering Co., Kearney. Estimated cost $60,000.

N. J., Newark—Guilbert & Bettle, 20 Branford Pl., Archts., will receive bids about June 15, for a 10 story hospital, nurses home, power house, etc. on Newton St. for Newark Memorial Hospital, W. F. Hoffman, Pres., 340 Bank St. Estimated cost $1,250,000.

N. J., Perth Amboy—Amboy Ice Mfg. Co., c/o B. Goldberger, 117 Smith St., is having preliminary plans prepared for the construction of an ice plant at Fayette and Goodwin Sts. Estimated cost $50,000. B. Goldberger, 117 Smith St., is architect.

N. Y., Buffalo — City, G. Fisk, Municipal Bldg., will receive bids until June 17, for the construction of a 31 story office building at Niagara Sq. Estimated cost $6,000,000. Dietel, Wade & Jones, Genesee Bldg., are architects.

N. Y., Fillmore — Rochester Gas & Electric Corp., R. M. Searle, Pres., 89 East Ave., Rochester, plans the construction of an electric light plant here.

N. Y., Forestport—Old Forge Electric Corp., has been granted permit to construct an electric light plant for furnishing light, heat and power to Forestport in Oneida county extending from Forestport along present state highway toward Old Forge to the Herkimer-Oneida county line.

N. Y., New York—Milton Barkin Realty Co., 64 West 48th St., will build a 21 story apartment building at Central Park W. and 92nd St. Estimated cost $4,000,000. H. L. Feldman, 415 Lexington Ave., is architect. Work will be done by separate contracts.

N. Y., New York—Dept. of Parks, will receive bids in August or Sept. for the construction of a power plant and service building for American Museum of Natural History, Columbus Ave. and 77th St. Estimated cost $1,255,000. W. Hohauser, Inc., 17 West 44th St., is architect.

N. Y., New York—Trebuhs Realty Corp., L. Shubert, Pres., will build a 34 story hotel at 911 8th Ave. Estimated cost $4,500,000. H. J. Krapp, 1 West 47th St., is architect.

N. Y., Yonkers—S. Steinmetz, 61 School St., will soon award contract for the construction of a cold storage plant on School St. Estimated cost $200,000. J. Watson, City Hall, is architect.

O., Toledo—Hocking Valley R. R., Columbus, awarded contract for the construction of ore and coal docks, loaders and elevators, etc. here. Estimated total cost $6,000,000. W. Michel, is chief engineer.

Ore., Medford — Medford Ice & Storage Co., plans the construction of an ice and cold storage plant. Estimated cost $80,000 to $100,000. A. T. Berger, is architect.

Tex., El Paso—C. N. Bassett, c/o State Bank, plans the construction of a 13 story office building including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. Estimated cost $500,000. Trost & Trost, Two Republics Bldg., are architects.

Tex., Del Rio—Central Power & Light Co., Frost Bldg., San Antonio, awarded contract for the construction of a power plant, 20,000 hp. capacity of Devils River near here to L. E. Myers Construction Co., Allen Bldg., Dallas. Estimated cost $1,500,000.

Tex., Gainesville—Lone Star Gas Co., plans the construction of a compressor sub-station. Estimated cost $75,000. Private plans.

Tex., San Antonio — McKenzie Construction Co., Travis Bldg., Contrs., will soon award contract for air cooling and ventilation systems for proposed 22 story bank and office building for Alamo National Bank, E. L. Brown, Pres., 128 West Commerce St. Estimated cost $1,500,000.

Tex., San Antonio—J. J. Nix, Travis Bldg., awarded contract for a 20 story office building, etc. at Navaroo and College Sts. to J. P. Haynes, Moore Bldg. Estimated cost $1,250,000. Steam heating, ventilation and refrigeration systems, boiler elevators, etc. will be installed.

B. C., Vancouver—Harbor Comrs., 525 Seymour St., plans the construction of wharf and cold storage plant at Barrard Inlet. Estimated cost $1,500,000. H. W. Fritch, 525 Seymour St., is engineer.

Ont., Belleville — Belleville Arena, Ltd., is having plans prepared for the construction of an artificial ice hockey and skating arena. Estimated cost $30,000 to $40,000. Thompson & Johnson, 224 Front St., are architects.

Ont., Toronto—Canadian Pacific Ry. Co., H. O. Windsor Sta., Montreal, Que., awarded contract for the construction of a round house, ash handling plant, etc. here to Anglin-Norcross Ltd. Temple Bldg., Toronto. Estimated cost $800,000.

Ont., Toronto—Dept. of Public Works, Parliament Bldg., Ottawa, will receive bids until July 4, for a 5 and 6 story customs building including steam heating system, elevators, etc. Estimated cost $2,000,000.

Ont., Wheatley—City Council, plans an election June 17, to vote $45,000 bonds for waterworks system including pumps, etc. A. W. Connor, Metropolitan Bldg., Toronto, is engineer.

Equipment Wanted

Air Compressors — City of Stratford, Ont., three electrically operated air compressors, 500 cu.ft. per min. capacity, for proposed sewage disposal plant. Estimated cost $48,000.

Boilers—Charity Hospital, F. W. Matthews, Secy. & Treas., New Orleans, La., will receive bids until June 14, for furnishing, erecting and entire completion of two high pressure boilers and breeching.

Generator Unit — City of Clarksdale, Miss., will readvertise for bids soon for power plant equipment including a 2,000 kw. turbo-generator unit, 3 ph., 60 cycle, 2,300 v.

Generator Units—Constructing Quartermaster, Fort Huachuca, Ariz., will receive bids until June 10, for two Diesel engine generator units.

Pump, Engine and Motor — Water Commissioners, Waterloo, Ont., prices on 1,250,000 g.p.m. pump and 1,800 hp. Diesel engine with motor as an emergency waterworks plant. Estimated cost $50,000.

Pumping Equipment—City of Collinsville, Ill., will receive bids late in Summer for pumping equipment for proposed sewage disposal plant. Estimated cost $300,000.

Pumping Unit—Bd. of Comrs., City Hall, Newark, N. J., plans furnishing and installing a pumping unit for proposed sewage treatment work. Estimated cost $100,000.

Pumping Unit — Passaic Valley Sewerage Commission, 24 Branford Pl., Newark, N. J., will receive bids until June 18, for a pumping unit for Newark Bay pumping station. Estimated cost $25,000.

Pumps — City of Dresden, Ont., electric pumps, etc. for proposed waterworks system. Estimated cost $25,000.

Pumps, Motor, Generators, etc.—City Council, C. A. Waterous, Chn. of Water Bd., Brantford, Ont., three low lift and three high lift motor driven centrifugal pumps, motor, three crude oil engine driven electric generators, etc. for proposed waterworks filtration plant. Estimated cost $540,000.

Turbine—City, c/o R. G. Price, Clk., Moorhead, Minn., will receive bids until June 10, for furnishing and installing a new steam turbine for water and light plant. Estimated cost $50,000.

Turbine—City of Carson City, Nev., G. W. Malone, State Engr., will receive bids until June 10, for a deep well turbine direct connected to vertical electric motor for proposed waterworks improvements

Industrial Projects

Ala., Gadsden — PLATE MILL — Gulf States Steel Co., L. E. Geohegan, V. Pres. and Gen. Mgr., Birmingham, awarded contract for an electrically operated plate mill, 25,000 tons per month capacity here to Macintosh-Hemphill Co., Ft. of 12th St., Pittsburgh, Pa. Estimated cost $1,500,000.

Ala., Needham—BRICK and CLAY PLANT—Choctaw Clay Corp., R. J. Wilkinson, Pres., New Orleans, La., plans the construction of a plant here for the production of oxidized clay and Fuller's earth for the market also insulated brick. Estimated cost $500,000.

Calif., South Gate—FIRE and RUBBER FACTORY ADDITION—Firestone Tire & Rubber Co., 1165 Figroa St., Los Angeles, awarded contract for a 180 x 460 ft. addition to factory to J. V. McNeil Co., 5860 Avalon Blvd. Estimated cost $1,000,000.

Conn., Waterbury—CLOCK FACTORY—Lux Clock Mfg. Co., 97 Sperry St., is receiving bids for a 4 story, 45 x 150 ft. factory on Johnson St. Estimated cost $150,000. T. M. Freney, 51 Leavenworth St., is architect.

Mich., Dearborn — AIRPLANE FACTORY — Stout Airplane Division, Ford Motor Co., is having plans prepared for a 1 story, 190 x 600 ft. factory at Oakwood Blvd. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Mich., Lansing—AUTOMOBILE PARTS FACTORY—Olds Motor Works, Olds Ave., will soon award contract for a 1 and 3 story, 125 x 460 and 32 x 200 ft. factory. H. E. Beyster, 9-261 General Motors Bldg., Detroit, is engineer. Electric motors and miscellaneous machine shop equipment for finishing motor parts will be required.

N. J., Newark—MOTOR CAR FACTORY—E. C. Epple, 44 Commerce St., Asso. Archt., will receive bids about June 15, for a 3 story, 200 x 206 factory at Central Ave. from 16th to 17th Sts. for Packard Motor Car Co., Broadway and 61st St., New York. Estimated cost $300,000. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

N. J., Paterson — AIRPLANE FACTORY — Wright Aeronautical Corp., 139 Railway Ave., is having sketches made for a 1 story factory on Madison Ave. Estimated cost $750,000. Private plans.

N. Y., Utica—RAYON PLANT—Skenandoa Rayon Corp., M. Gordon, 1201 Broad St., is having plans prepared for addition to rayon plant. Estimated cost $3,500,000. W. E. Dyer, Land Title Bldg., Philadelphia, Pa., is architect.

N. C., Yadkin—FINISHING MILL—North Carolina Finishing Co., awarded contract for a 75 x 130 ft. addition to mill to Potter & Shackelford Inc., Greenville, S. C. Estimated cost $65,000.

O., Youngstown—STEEL DOOR FACTORY—Youngstown Steel Door Co., awarded contract for a 1 story factory including shops, etc. to Heller-Murray Co., 222 West Rayen St. Estimated cost $250,000.

S. C., Rock Hill — FINISHING MILL and BOILER HOUSE — Rock Hill Printing & Finishing Co., awarded contract for a 2 story, 225 x 478 ft. mill and 52 x 75 ft. boiler house, etc. to Brown-Harry Construction Co., Gastonia.

Ont., Chatham—FACTORY—Hayes Wheel & Forgings Ltd., plans the construction of a 1 story, 200 x 400 ft. addition to factory for the manufacture of auto wheels, universal joints, shafts, clutches and rear axles on King St. Estimated cost $250,000. Private plans. Equipment will be required.

Ont., Oshawa—AUTOMOBILE BUMPER FACTORY—Skinner Co. Ltd., Gananoque, plans the construction of a 100 x 400 ft. factory for the manufacture of automobile bumpers. Estimated cost $200,000. Engineer not selected.

Ont., Toronto—FACTORY—James Morrisson Brass Mfg. Co., 93 Adelaide St. W., plans the construction of a 4 story factory for the manufacture of gauges, valves, plumbing supplies, etc. Estimated cost $160,000. Private plans.

Ont., Toronto — KNITTING MILL and POWER PLANT — Model Knitting Mills, 162 John St., is having plans prepared for a 7 story mill including power plant, etc. Estimated cost $100,000. B. Swartz, 336 Dundas St. W., is architect.

Ont., Windsor — SPARK PLUG FACTORY — Champion Spark Plug Co., A. Hayres, Mgr., is having plans prepared for addition to factory on Victoria Ave. Estimated cost $150,000. Equipment will be required.